Signature
EDITION™

ATARI
MEDIA SYSTEMS

Pro Pack

5200 TM

Signature Edition

Volume 1

Signature Edition

Volume 2

TECHNICAL REFERENCE MANUAL

U. S. AND FOREIGN PATENTS ISSUED AND PENDING.

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Chapter 1 — GENERAL INFORMATION

1.1 INTRODUCTION

NOTE: The changes from 7100F/7200F to 7100G and 7200G are software only — added event log, auto zero enable/disable and real time software clock.

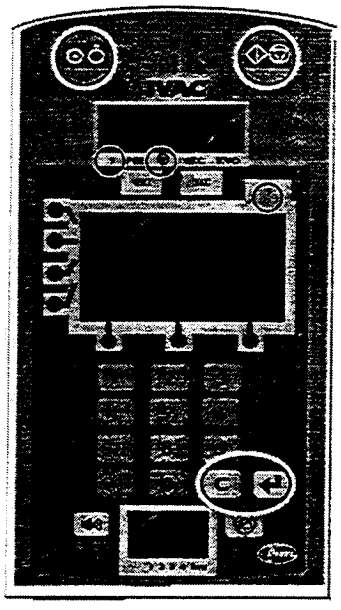
This manual covers Signature Edition versions with software 2.44 and higher and is the initial release of the 7101A/7201 version. Series includes 7100F, 7200F, 7100G, 7200G, 7101A and 7201A. 710X means 7100 and 7101 iterations.

There are two specific model groups — 7100G/7200G and 7101A/7201A. The key differences are:

HARDWARE — The 7101A/7201A Series is labeled for 220V with two power cord options and has isolated RS232 Board, potential equalization (PE) connector, drop sensor board installed. There is no Nurse Call option. The keypad has symbols instead of words.

SOFTWARE — The 7101/7201 Series has no drug list (Drug ? only), some defaults are different in configuration mode and there are seven (7) languages to choose from.

NOTE: The 7101/7201 Keypad uses symbols instead of words.



The IVAC Signature Edition system includes the SE I — Model 710X, and SE II — Model 720X Volumetric Infusion Pumps and AccuSlide™ administration sets.

Refer to the Directions for Use manual for complete information regarding the setup and operation of the pump.

The Model 7100/7200 Series pump is a 100-240 VAC, 50/60 Hz instrument family that supports both single and dual channel fluid delivery. Each instrument carries identification labels designating its model and serial number.

The pump features user-interactive software. It displays prompts, alarms and alert messages, and troubleshooting information on the main LCD display of the instrument. The pump can be configured to your specific operational requirements and allows upgrades for future product enhancements. The pump has been designed to interface with accessory equipment including nurse call system and/or computer monitoring system.

NOTE: Refer to the ALARIS Medical Systems Warranty before servicing the pump. Any attempt to service an ALARIS Medical Systems instrument by anyone other than an authorized ALARIS Medical Systems service representative may invalidate the ALARIS Medical Systems Warranty. ALARIS Medical Systems offers a variety of repair agreements for post-warranty service. Call toll-free (800) 482-4822 (ALARIS Medical Systems) for information.

This manual contains instructions for maintenance, repair, and configuration of the instrument. The maintenance and repair sections of the manual are written for personnel experienced in the analysis, troubleshooting, and repair of analog and digital microprocessor-based electronic equipment.

Specifications

RATE RANGE: 0.1 to 999.9 ml/hr in 0.1 ml/hr increments (primary)
0.1 to 270.0 ml/hr in 0.1 ml/hr increments (secondary)

VOLUME TO BE INFUSED RANGE: 0.1 to 9999.9 ml in 0.1 ml increments (primary)
0.1 to 999.9 ml in 0.1 ml increments (secondary)

VOLUME INFUSED RANGE: 0.0 to 9999.9 ml in 0.1 ml increments

KVO RANGE: 0.1 to 20.0 ml/hr in 0.1 ml/hr increments

SYSTEM ACCURACY ± 5%*

ALARMS:

- Air In Line
- Battery Depleted
- Channel Malfunction
- Computer Link Failure
- Flow Sensor Unplugged
- Hold Time Exceeded
- Instrument Malfunction
- Key Stuck
- Latch Open
- No Upstream Flow Detected
- Occlusion Downstream
- Occlusion Upstream
- Primary Flow Detected During Secondary
- Set Up Time Exceeded
- Set Out

DIMENSIONS:

	7100/7101	7200/7201
Width	7.6 in/19.3 cm	10.5 in/26.7 cm
Height	8.6 in/21.8 cm	8.6 in/21.8 cm
Depth§	5.0 in/12.7 cm	5.0 in/12.7 cm
Weight§§	6.6 lbs./2.9 kg	8.4 lbs/3.7 kg
Power Cord	10ft/3 m	10ft/3 m

§without pole clamp §§without power cord

CASE: Impact resistant plastic

ADMINISTRATION SETS: Use only IVAC 72 series administration sets. All disposable IV set and IV set accessory models are defined on a separate card included with this *Directions for Use*.

POWER REQUIREMENTS: 100-240V ~, 50/60 Hz, 0.6A ~, 72VA max — 3-wire grounded system. Class 1 with Internal Power Source.

MODE OF OPERATION Continuous

GROUND CURRENT LEAKAGE: Risk Current (normal/single fault condition)
Ground (enclosure) leakage current: less than 100/500 µA (normal/single fault)
Patient leakage current: less than 10/50 µA (normal/single fault)

BATTERY: Rechargeable nickel cadmium. Use only IVAC Nickel Cadmium or Nickel Metal Hydride, 12V, 1.8AHr (minimum) batteries.With a new, fully charged battery, the pump will operate for 4 hours nominal at 100 ml/hr for a two channel instrument operating on both channels simultaneously.

With a fully charged, new battery at 25°C, volatile memory configuration information will be retained for at least 6 months. Interrupted secondary or advanced operating modes retain special program settings up to six hours. Additionally, Resistance Trending information is retained for 6 hours.

MAXIMUM BOLUS VOLUME (ml) At 1.0 ml/hr: 0.5 ml;* At 25 ml/hr: 0.5 ml*

MAXIMUM TIME TO ALARM (ml) At 1.0 ml/hr: 60 min*.; At 25 ml/hr: 2 min*.

MAXIMUM INFUSION PRESSURE 16 psi*

OCCLUSION ALARM PRESSURE 12 psi ±4psi, not adjustable*

CRITICAL VOLUME: Maximum incremental volume in case of single point failure will not exceed 1.0 ml @ 999.9 ml/hr.

ENVIRONMENTAL CONDITIONS:

	Operating	Storage/Transport
Temperature Range:	10°C to 40°C (50°F to 104°F)	-40°C to 60°C (-40°F to 140°F)
Relative Humidity:	15 to 90% Non-condensing	5 to 95% Non-condensing
Atmospheric Pressure:	631 to 1031 mbar	631 to 1031 mbar

* *Testing performed per proposed standard IEC 601-2-24 using IVAC IV sets.*

1.2 Expanded Pump Specifications

Administration Set: Use only IVAC 72 Series administration sets.

When used for gravity infusion: Max. Gravity Flow Rate: >4200 ml/hr with 16 gauge catheter x 2.25" Teflon

Air-in-Line Accuracy:

Configured Threshold	Air Volume Detections Range
50µL	15µL - 85µL
100µL	35µL - 140µL
200µL	100µL - 235µL
500µL	275µL - 565µL

Altitude: Operating Altitude: -500 ft.(-150M) to 7,500 ft. (2285M)

Battery: 500 charge/discharge cycles, minimum under nominal charging conditions
Recharge time while instrument is running, is 4 hours to 95% capacity
+50%, -0% battery gauge accuracy

Case: Impact resistant plastic, flame retardant

Fluid Ingress Rating: Drip proof IPX1

Ground Current Leakage: (7100/7200) <100 µAmps.120Vrms
Tested to UL Standard 544 and CSA C22.2 No.125 for medical and dental equipment.

Parts per ml: 1150 steps to deliver 1 ml (Rate cal #191)

Programmable Features: (Configuration)
Air-in-line alarm threshold: 50, 100, 200, or 500 µl
Air-in-line reset feature: On/Off
Audio: Hi/Med/Lo levels accessible

These features can be customized by qualified service personnel.
Communications: Baud Rate, Parity
Computer control: Control, Monitor, Off

Configuration is not lost when disconnected from AC power and/or battery power.
Configuration Name: 4 bit alpha-numeric code
Display language: Choice of two or seven
Dose Rate Calculation: On/Off
Drug? Access: On/Off
Drug Specific Access: Short/Extended/Off (7100X/7200X only)
Dynamic Monitoring™

Mode: Hi Resistance/Resistance/Pressure Only
Alert: On/Off
Restarts: 0 (Off), 1-9
Resistance Display: On/Off
Resistance Trend Graph: On/Off
Instrument ID: 9 digits
KVO rate: 0.1 - 20.0 ml/hr
Loading Dose: On/Off
Panel lock: On/Off
Preventive maintenance interval 1-52 weeks
Preventive maintenance reminder: On/Off
Maximum rate: 0.1- 999.9 ml/hr
Multi-Dose Alert: On/Off
Multi-Dose Mode: On/Off
Multi-Step Mode: On/Off
Transition tone: On/Off
VTBI: ON/OFF (7101/7201 or flow sensor modification)

Rate Accuracy: ±5% typical at 30" delivery container head height

RFI: Tolerate > 10 V/m across frequency range

Temperature: Operating above 30°C, for extended periods, will reduce battery life.

Volume to Be Infused Range:
0.1 to 9999.9 ml in 0.1 ml increments (primary)
0.1 to 999.9 ml in 0.1 ml increments (secondary)
0.1 to 999.9 ml in 0.1 ml increments (loading dose)
0.1 to 9999.9 ml in 0.1 ml increments (dose rate)
0.1 to 999.9 ml per step in 0.1 ml increments (multi-step)
0.1 to 999.9 ml per dose in 0.1 ml increments (multi-dose)

Warnings:

- Battery Low
- Checking Line
- Computer Control Released
- Dose Complete
- Load Dose Complete
- Multi-Step Complete
- Resistance Alert
- Secondary Complete
- VTBI = 0

1.3 Battery Management System

This section contains general information on the battery management system. Included is information on how the Battery Manager monitors and maintains the battery, controls the power on/off for the rest of the instrument, and provides support functions for the main processor. Refer to Chapter 4 for more detailed functional descriptions.

The battery management system consists of the Battery Manager IC and various sensors and signal processing circuits. The Battery Manager IC (Rev. 3.06) is a custom programmed microcontroller that performs the following functions:

- Controls the battery charger
- Provides a battery status "battery gauge"
- Monitors voltage and temperature of battery
- Controls the instrument power source (on/off function)
- Drives the Lower LCD Display (See Figure 1-1)
- Includes a relative-time clock

The Battery Manager communicates with the main processor via a serial data channel. The main processor issues commands to the Battery Manager which then responds with status information and data using this channel.

1.3.1 Fan

The internal fan is used for cooling, mainly to help prolong battery life. It is a ball bearing, brushless DC fan.

The fan is always on when battery is charging with "Fast" or "Top-up" charge. The fan will go on any time battery temperature is over 22°C.

1.3.2 Battery and Charging Process

The battery is a ten cell (1.2V per cell), high capacity nickel-cadmium type rated at 12 volts and 1.8 amp-hours (with a minimum of 500 charge/discharge cycles).

The battery pack (10 to 18V) has a built-in temperature sensor which allows the Battery Manager to monitor the temperature of the battery. The pack also includes a temperature limiting thermostat which opens the circuit if the battery temperature gets too hot and closes again when the temperature returns to normal.

The battery charge circuit charges the battery with a constant current of 1 ampere whenever the Battery Manager turns the charger on. The Battery Manager regulates average charge current by turning the charger on and off with the appropriate duty ratio. The battery charge cycle consists of four modes; fast charge, top-up charge, float charge, and hot charge.

a. Fast Charge: Fast charge is initiated whenever the battery is less than 36°C, and has been discharged by more than 200 Ampere-seconds through actual use or self discharge. Leaving the instrument unplugged for a day would cause about 200 Ampere-seconds of self discharge. The charge current is a continuous 1 Ampere. The end of a fast charge is detected when the temperature of the battery rises 7°C above its temperature at start of charge and is at least 30°C, or when the battery voltage declines by 192mV below its peak value, or total charge time exceeds 3.2 hours. Also refer to Battery Charge Regulator section (4.5.3) for further details.

b. Top-Up Charge: The top-up charge phase begins at the end of the fast charge phase and finishes adding the last few percent of charge to the battery and balances individual cell charges. This phase charges at an average rate of 180 mA (1A for 0.9 seconds every 5 seconds) for 180 minutes. At that time,the instrument will go into float charge mode. The charger will suspend top-up if the battery temperature exceeds 37°C. The time spent to cool down to below 37°C is in addition to the 180 minutes top-up charge time. If top-up cool down time exceeds 5 1/2 hours, the instrument will go into float charge mode.

c. Float Charge: The float charge phase begins at the end of the top-up phase and helps maintain a fully charged battery. This phase charges at an average rate of 40 mA (1 A for 0.2 seconds every 5 seconds). The fan remains on or turns on when battery temperature exceeds 22°C.

d. Hot Charge: The Hot Charge Mode occurs when the instrument determines that the battery is >36°C (normally due to ambient temperature being >27°C) to allow a charge after waiting 3 hours for it to cool down. Hot Charge Mode charges at an average rate of 180 mA (1A for 0.9 seconds every 5 seconds) for a total charge time of 18 hours. If the battery temperature exceeds 43°C, the charging is turned off until the temperature falls below 43°C. Note that the cool down time is in addition to the 18 hour charge time. The float charge cycle begins at the end of the hot charge cycle.

Table 1-1 Battery Trip Points

Battery Voltage	Instrument Response
12.0V (Single) 12.1V (Dual)	• 15 minutes left on gauge • Unit continues to function • Warning tone activated • Low battery warning
11.45V	• Unit does not pump • Constant alarm • Low battery alarm (Depletion)
10.25V	• 1 min or longer (nominal 5 min.) after low batt alarm • Backup speaker activated • Instrument shutdown (5 min. after alarm)
9.75V	• No AC power applied • Battery disconnected from circuit by shutdown signal

1.3.3 Refresh Cycle

A battery refresh cycle performs a full charge, discharge, and recharge to condition and measure the capacity of the battery. This refresh results in a new "Measured Capacity" in the battery diagnostics and can be used to judge the condition of the battery. The refresh cycle must be initiated manually, either by disconnecting/reconnecting the battery or by loading 0.0 A-H as the rated capacity in the battery diagnostics page. After the zero rated capacity is loaded and the OK button is pressed, the original rated capacity must be reloaded to preserve the battery gauge. The empty "E" icon will flash during the discharge part of the refresh cycle. The AC power must remain connected and uninterrupted during the discharge cycle. If the AC power is removed during this cycle, the discharge cycle will be terminated and another refresh cycle will have to be initiated. The time for complete refresh is dependent upon battery temperature and takes an average of 20 hours to complete.

Two ways to initiate a manual refresh cycle are:

1. Disconnect from AC, unplug the battery, then press the power switch. The lower LCD will go blank. Reconnect the battery then plug the pump into AC.
2. Enter Diagnostics Mode, go to page D2, and enter 0.0 Ah for battery rated capacity. Press Enter and **ok**. Turn pump off and back on, then plug the pump into AC. Once the fan turns on (indicating the start of a refresh cycle), return to page D2 and reset the battery rated capacity to 1.3 Ah (with battery manager software 3.01 and higher).

1.3.4 Battery Gauge

The battery gauge provides an indication to the user of the approximate amount of time the instrument will run on battery power. It will usually indicate less run time than the user will actually get on a new battery. This is displayed in a bar graph format on the lower LCD Display and is active as long as the battery is connected to the instrument. The display indicates up to 4 hours in 15 minute increments. (See Figure 1-1, Lower LCD Display Layout)

The battery gauge circuitry measures the current flow into and out of the battery and maintains a record of the state of charge of the battery. This record is reset each time the pump completes a full refresh cycle. The battery gauge uses this record, together with a measurement of the present power requirements of the instrument, to estimate the time available on battery power at the current infusion rate.

NOTE: When the instrument is turned off, the gauge will indicate approximate run time for infusions of 125 ml/hr.

1.3.5 Power On/Off

The Battery Manager provides the interface between power on/off switch(es) and the main processor. When the instrument is off, the Battery Manager interprets either power switch as a turn on command and applies power to the rest of the instrument, informing the main processor which switch was pressed. Once power is on, further presses of a power switch are passed on to the main processor which determines the appropriate response under the existing conditions. If the response is to turn the power off, the main processor requests that the Battery Manager remove power from the rest of the instrument.

If an error has been detected which causes the watchdog to be in alarm, a push of either power switch will immediately cause the power to be turned off, without intervention by the Battery Manager.

1.3.6 Lower LCD Display

The Battery Manager also contains the driver for the Lower LCD Display. In addition to the battery gauge, this display contains a four character alphanumeric "configuration" display and several icons. The information for these other displays is controlled by the main processor and is communicated to the Battery Manager through the serial channel. The Battery Manager also uses the four character display to indicate errors detected in the Battery Manager system itself.

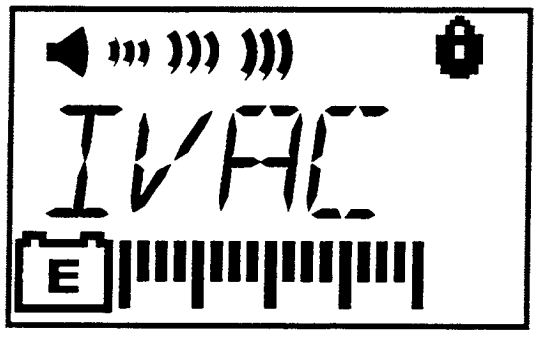


Figure 1-1 Lower LCD Display Layout

1.3.7 Clock

The Battery Manager provides a "`relative time`" clock which the main processor can set and read. This clock consists of a 32 bit counter which is incremented once a second under all conditions. The main processor uses this counter as a means of determining elapsed time even when power has been turned off. The clock is used to determine when a battery refresh cycle is required as well as compensating for normal battery capacity degradation over time.

1.3.8 Battery Maintenance

CAUTION: Use only ALARIS™Medical approved batteries due to Battery Manager requirements and the thermostat contained in the battery assembly.

Connect pump to AC before turning pump on if it has been in storage. Usually one refresh cycle is sufficient to restore battery capacity. If necessary, repeat the procedure at 24 hour intervals, 2 or 3 times, to increase capacity.

Several features have been included in the Battery Manager to help properly maintain the battery.

- A measurement of the capacity of the battery is available in the diagnostic mode.
- A special circuit removes all load from the battery when the voltage falls too low, preventing damage from over discharge due to long term storage.

NiCd batteries can be stored indefinitely with no load but will self-discharge from a charged state in about 100 days. This does not damage the battery as it would if it were a lead acid type battery. Connect instrument to AC to recharge batteries.

NOTE: If under load (inside instrument), the maximum storage time would be about 130 days before electrolyte extrusion occurs past the battery seal.

If the battery exhibits short run times, a reconditioning procedure can be used. Disconnect battery and AC, press the On/Off switch and verify

lower LCD goes blank. Reconnect the battery. Plug instrument into AC. A refresh cycle will be initiated. Repeat this procedure at 24 hour intervals, 2 or 3 times to increase capacity or use a battery conditioner.

CAUTION: Dispose of or recycle battery following hospital protocol. Refer to your institution's operating procedures, your state's EPA guidelines for disposal of battery or contact Rechargeable Battery Recycling Corporation (RBRC) at 1-800-822-8837.

1.4 Nicd Battery Capacity Information

All batteries have specific conditions under which they are guaranteed to meet their published specifications. Deviations from these conditions typically result in a reduction of available capacity. Manufacturers of nicd batteries rate capacities, usually expressed in Ah (Ampere-Hours), based on a specified "ideal" charge and discharge condition as well as the use of a "new" battery. Battery Manufacturer's date codes start on 9/1 of the upcoming year (e.g. date code 9611 = first week of November 1995).

An ideal charge cycle starts with a fully discharged battery charged at C/10 (C is the rated capacity in Ah) constant current for 15 hours while at room temperature. For instance, a 1.8Ah battery would be charged for 15 hours at 180mA constant current with a room temperature of 23°C.

The ideal discharge starts with a fully charged battery under a C/5 constant current load at room temperature discharging to a cell voltage of 0.9V. The rated capacity is then calculated as the time to discharge divided by 5. Again, a 1.8Ah cell would be discharged at 360mA constant current and not reach 0.9V for at least 5 hours. Note that a given battery type has different capacities based on the load. For instance, a battery rated at 1.8Ah at a 360mA load may have only 1.6Ah at a 1600mA load.

As can be seen from the preceding ideal conditions, there are many conditions which can affect the battery capacity. The following conditions have the most practical impact on battery capacity delivered in this instrument.

a. TEMPERATURE DURING CHARGE - As the effective ambient temperature of the battery increases, the amount of charge that the battery will accept is decreased. At an ambient temperature of 35°C, an enclosed battery will temporarily accept only about 90% of the charge it would otherwise accept at 23°C. Since the batteries are internal to the instrument case, they will be exposed to temperatures above room temperature since the instrument itself generates heat. Some of the ways the instrument limits the temperatures that the battery sees include forcing air across it (an internal fan) and turning off the charger when the battery temperature gets too high.

b. CYCLE LIFE AND AGING - As batteries get older and go through many charge/discharge cycles, batteries "wear out" in that the chemicals and materials used to construct the cell break down. The way the instrument deals with this is to assume that a battery will continually reduce capacity at a rate equivalent to 30% over 4 years and continually reduce capacity at a rate equivalent to 30% per 200 full discharge/charge cycles. These calculated values are used to reduce the runtime displayed on the battery gauge.

c. PARTIAL DISCHARGE/RECHARGE - When a battery is partially discharged, then charged for less than the full time, differences between individual cell capacities result in cells completing charge at different times. If the full charge sequence is not then completed, the cell "mismatch" becomes progressively greater. This is viewed by the user as low apparent runtimes and premature low battery warning and alarms. The problem is cumulative in that the mismatch increases for every partial cycle. The lowered capacity is not permanent, but may require 2-3 full discharge/charge cycles to recover. The way the instrument deals with this is to reduce the runtime displayed based on a limited history of partial cycles.

d. CHARGE RATE - The ideal charge rate requires 15 hours to get to full charge, which is undesirable from the user's perspective. The instrument provides a multiphase charge cycle which results in about 80% capacity in the first 2 hours after Fast charge. The next charge phase, Top-up, is designed to finish the charge and to bring all individual cells to the fully charged state, essentially rematching them. Refer to Section 1.3.2 for Fast Charge and Top-up Charge information. If the Top-up charge is not completed, then the cell mismatch is not reduced and the cumulative capacity reduction occurs. Top-up is a 3 hour charge, but the elapsed time to complete it may be over 5 hours as the charger is turned on and off to keep the battery cool during that time.

e. BATTERY ALARM VOLTAGE - The battery alarm voltage is the voltage at which the instrument stops operating and generates an alarm to tell the user to plug it into AC line. As noted in the ideal discharge condition, the end of discharge is determined by 0.9V/cell. Under perfect conditions, a battery of 10 cells connected in series would reach the end of discharge at 9.0V. However, cells are not perfectly matched so some will reach 0.9V before others. The problem occurs when a cell in series with other cells can go below 0.9V and actually can go into cell reversal, which permanently damages the particular cell. On the other hand, increasing the alarm voltage to compensate for imperfectly matched cells results in reduced runtimes with available capacity. The user sees this as premature low battery warnings and alarms. The way the instrument deals with this is to increase the alarm voltage to guarantee the battery is not damaged and reduce the assumed capacity to below that printed on the battery. The battery gauge is intended to show the minimum run time left on the battery taking all these factors into account.

NOTE: In the future, ALARIS Medical Systems may provide different battery packs. The replacement battery may have a different rated capacity. Therefore, the Battery Manager of the instrument needs to know that a new battery has been added and the rated capacity has changed. Refer to Section 5.3 "Replacing Battery" and Section 6.4.6, Changing Rated Capacity of Battery.

1.5 Dynamic System Monitoring™ (DSM)

The following is general information regarding the Dynamic Monitoring™ system as it relates to the Signature Edition instrument.

In order for fluid to move through the administration set, a pressure difference (gradient) must exist. In a gravity setup, this is done by head height. In a pump, the instrument will develop pressure to overcome downstream effects on fluid flow.

The fundamental concept behind the Dynamic Monitoring™ system is that the resistance to fluid flow from the mechanism to the patient's infusion site can be measured. This is done by intentionally varying the flow rate while monitoring the resulting changes in fluid pressure. Refer to Figure 1-2 "Resistance Graph". Signal processing of the pressure and flow data can then produce the fluid impedance value. Such measurements can be made continuously at short intervals and be independent of the selected rate. Head height and resulting pressure variations, likewise, will not affect the measurement.

When a complete occlusion occurs, the resistive part of the fluid impedance is very large (theoretically infinite). Elevated resistances due to clotting, clogged filters, partial occlusions or infiltrations can be measured.

The Dynamic Monitoring™ system provides a means to measure the mechanical properties of the downstream flow path.

Pressure = Effect when a force is against a restriction.
Resistance = Cause when impediment to fluid flow occurs.

$$\textit{Resistance} = \frac{\textit{Change in Pressure } (\Delta P)}{\textit{Change in Flow } (\Delta F)}$$

Refer to Figure 1-3 "Pressure and Resistance Graph".

Features include:

- Alarm setting is based on dynamic system impedance (pressure changes, not absolute pressure).
- Detection of complete occlusions.
- Reduced nuisance alarms by minimizing artifact effects such as head height and patient movement.
- Faster time to alarm at low rates.
- The AutoRestartPlus™ feature allows the pump to automatically continue operation if an occlusion is cleared within the self-check period (40 seconds). A warning tone and "Checking Line" message will occur for up to 40 seconds. The feature can be turned off (set the restarts to zero), or the number of restarts may be set from 1 to 9.

NOTE: The restart counter is reset whenever the clinician presses Run/Hold, if the pump or channel is turned off, or if an alarm occurs.

NOTE: When infusion is started, the resistance may be other than 0%, depending on solution viscosity, catheter/tubing size and filters.

- Resistance Alert, provides an early warning of slow or gradual changes in the resistance of the IV line/site. The Resistance Alert marker can be set from 5 to 100%. It allows the nurse to monitor resistance and will provide a tone every 30 seconds if the percent resistance exceeds the resistance alert mar
- The resistance display may be turned off. If off, the system will continue to monitor downstream resistance and alarm appropriately.

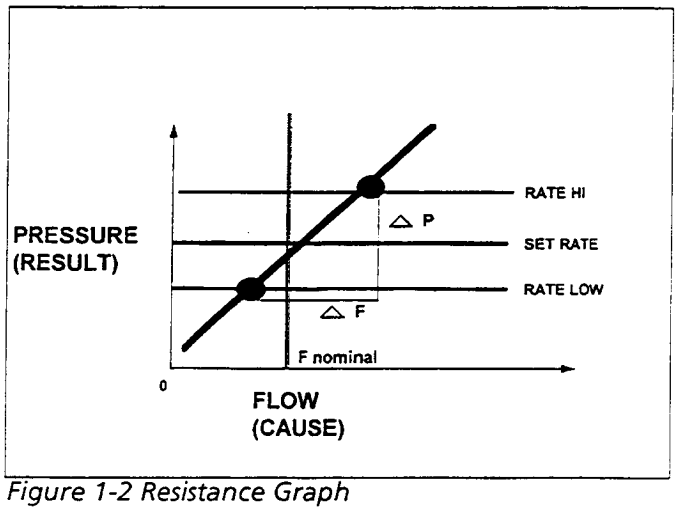


Figure 1-2 Resistance Graph

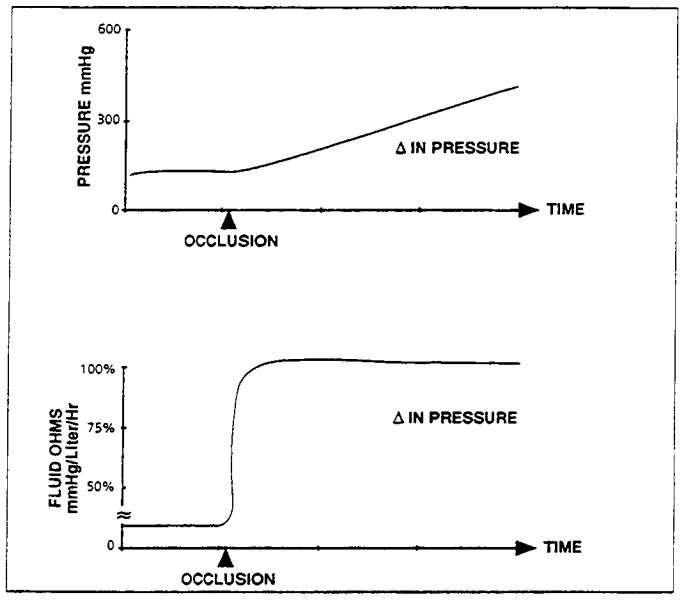


Figure 1-3 Pressure and Resistance Graph

Pressure rise is quite small with site complication, especially with low flow rates.

Resistance rises dramatically with site complication.

1.6 Data Communications Function

The instrument has built-in remote monitoring capability. This allows features and their data to be monitored by a computer, providing a means to create advanced clinical systems. A separate manual on data communications is available and organized to support technical personnel with a wide range of experience and needs. The separate manual includes:

- General Information: Includes the phone number for technical support.
- Operation: The instrument's communications modes, controls, indicators, and procedures from the user's point of view.
- Instrument Setup: How to set the baud rate, enable or disable computer control, and other parameters.
- Electrical Interfacing: RS-232 background information, connectors and recommended wiring for common computers.
- Communications Protocol: Inquiry, response, and command codes, data formats, message sequences, and error detection.

1.7 Accessories

Accessory items are available for use with the instrument. These items are described in the following paragraphs.

1.7.1 Nurse Call *(7100/7200 only)*

All instruments are equipped with the nurse call feature. Alarms and some alerts from the pump will be relayed to the hospital's existing nurse call system. No operating features of the pump are changed. The pump will alarm with or without the nurse call. The only additional item needed is a cable with a 9 pin to mono phone jack (P/N 136111).

NOTE: This option is not available on 7101/7201 pumps.

1.7.2 Learn/Teach RS-232 Cable

This is a standard commercially available 9-pin Null Modem RS-232 cable (also ALARIS P/N 133450). The Learn/Teach RS-232 cable is used to connect two instruments for the purpose of transferring (downloading) configuration data from/to another instrument.

1.7.3 Flow Sensor

Flow sensor capability is available with an upgrade kit on 7100/7200. For 7101/7201 all that is needed is the drop sensors.

The flow sensor attaches to the administration set's drip chamber. It detects an empty solution container and verifies fluid flow. When installed, it will allow VTBI to be turned off. The Flow Sensor will not see drops falling if drip chamber is tilted more than 24°.

1.8 Summary of Precautions

The following is a consolidation of NOTES, CAUTIONS, and WARNINGS found throughout this manual. Each is repeated in context with its related subject matter.

A **NOTE** is information that is of particular importance to the reader.

A **CAUTION** is a precaution that, if not taken, can result in damage to equipment.

A **WARNING** is a precaution that, if not taken, can result in personal or patient injury.

1.8.1 Notes

NOTE: Refer to the ALARIS Medical Systems Warranty before servicing the pump. Any attempt to service an ALARIS Medical Systems instrument by anyone other than an authorized ALARIS Medical Systems service representative may invalidate the ALARIS Medical Systems Warranty. ALARIS Medical Systems offers a variety of repair agreements for post-warranty service. Call toll-free (800) 482-4822 for information.

NOTE: If under load (inside instrument), the maximum storage time would be about 130 days before electrolyte extrusion occurs past the battery seal.

NOTE: This option is not available on 7101/7201 pumps.

NOTE: When the instrument is turned off, the gauge will indicate approximate run time for infusions of 125 ml/hr.

NOTE: In the future, ALARIS Medical Systems may provide different battery packs. The replacement battery may have a different rated capacity. Therefore, the Battery Manager of the instrument needs to know that a new battery has been added and the rated capacity has changed. Refer to Section 5.3 "Replacing Battery" and Section 6.4.6, Changing Rated Capacity of Battery.

NOTE: The restart counter is reset whenever the clinician presses Run/Hold, if the pump or channel is turned off, or if an alarm occurs.

NOTE: When infusion is started, the resistance may be other than 0%, depending on solution viscosity, catheter/tubing size and filters.

NOTE: The instrument's configuration information is not lost when disconnected from AC power and battery power. However, error history and infusion program settings may be lost. If you want to save this information be sure to record before disconnecting power.

NOTE: It is strongly recommended that you review Table 2-1 for a complete list of defaults before selecting factory defaults.

NOTE: Setting the Maximum Rate below the preset KVO Rate will lower the KVO Rate. The KVO rate will not exceed the Maximum Rate.

NOTE: The maximum rate setting applies to all infusion modes.

NOTE: The KVO rate will not exceed the present Maximum Rate.

NOTE: If Display is off then the alert feature will automatically be turned off.

NOTE: Resistance trend graph data is lost when: 1) Clear is pressed, 2) Pump is off for more than 6 hours.

NOTE: Resistance measurement is restarted at 0% when: 1) Run/Hold is pressed to put on hold and again to start, 2) Dose ends in Multi-Dose mode, 3) Checking line message appears.

NOTE: Checking line alert applies to pressure, resistance and upstream occlusion with one tone at the beginning and a flashing popup display (on for 4 seconds, off for 6 seconds). No nurse call activation.

NOTE: Resistance alert will give an alarm tone every thirty seconds, with a popup display (on for 4 seconds, off for 6 seconds). Nurse call activated. This occurs when the resistance measurement is above the alert threshold or at 100% even when checking line.

NOTE: You will see a 4 digit alpha/numeric code next to the configuration name upon entering configuration mode. Refer to Section 2.4.1 "Entering Configuration Mode" . This code is only a hexadecimal reflection of your instrument's configuration name.

NOTE: If you have changed the configuration but not the name, the pump will display the option to rename before turning off or proceeding to the teach mode. Refer to Section 2.5.2 "Pop-Up Displays" for further explanation.

NOTE: Must have 4 characters in configuration name, use space (-) symbol to fill in any open character.

NOTE: Only the configuration settings will be transferred. The instrument ID number and the periodic maintenance settings from the diagnostics mode will not be transferred through LEARN/TEACH.

NOTE: Repeat allows you to re-attempt or teach the next pump.

NOTE: The Learn/Teach function will not work if revision level is not the same on both pumps or if the pumps are not the same model (ie 710x/720x to 7000A).

NOTE: Do not use 70RCS more than 40 times.

NOTE: Due to the Dynamic Monitoring feature, the rate is varied during operation. For this reason, ALARIS MEDICAL SYSTEMS does not recommend using automatic testers to check rate accuracy. Generally, these devices collect small samples and may cause the results to be incorrect even though the instrument is accurate.

NOTE: The main PCB board can only be replaced in pumps with main software Rev. 2.02 or higher.

NOTE: Do not use 70RCS more than 40 times.

NOTE: X's appear once pressure calibration is started or if pressure calibration is required.

NOTE: The main PCB board can only be replaced in pumps with main software Rev. 2.02 or higher.

NOTE: The alarm history is not stored in the EEPROM.

NOTE: Refer to Figure 4-5 "Battery Monitor" and Figure 4-6 "Main Power Supply" when following Sections 4.5.2 through 4.5.17.

NOTE: The charger will turn off if the battery gets too hot (>37° C) to let the battery cool down. Cool down time is not included in the 180 minute charge time.

NOTE: The instrument's operation, when the battery is disconnected, is the same as the Battery Manager generating the SHUT-DOWN signal and requires the instrument to be plugged into AC after the battery has been reconnected.*

NOTE: The tests to be performed on a just-repaired instrument depend on the level of repairs made to the pump.

NOTE: Instrument configuration will not be lost when disconnecting power. However, history and infusion program settings may be lost. If you want to save event log, record before proceeding.

NOTE: The instrument will not run with battery disconnected.

NOTE: The instrument will attempt to refresh the battery when it is first installed. This refresh may take in excess of 24 hours if the instrument is turned on.

NOTE: If replacing battery, ensure battery run time is cleared in Diagnostic Mode.

NOTE: Do not remove cover from back of power supply board. If it's loose, reinstall with RTV.

NOTE: Single channel pump routing is similar to Channel B (ChB).

NOTE: Exercise caution when removing connectors. Pulling on wires can break them. Wires and connectors must be replaced as part of an assembly. They cannot be repaired separately.

NOTE: When removing flex cables, carefully lift locking bar to remove cable from connector.

NOTE: Pay particular attention to wire routing. Wires should be routed back to initial scheme and similar to the example shown. This will prevent them from getting pinched and jamming the mechanism.

NOTE: The large capacitor for the backup speaker may be discharged before removing the board. Jumper across terminals of capacitor C-146 (C- 179) for one minute. See Troubleshooting Section for more information.

NOTE: Pay close attention to cable routing when disassembling the instrument. The cables are specifically routed to ensure they are not pinched or stressed when reassembled.

NOTE: Keypad pictures are for reference only and may not match your instrument.

NOTE: Cable routing may change over time to ensure wires are not pinched and ease of assembly and disassembly is maintained. When the pump was opened, if the cable routing was different, follow that cable routing scheme..

NOTE: Calibration coefficients for the transducer are stored in the EEPROM on the main board assembly. Once they have been calibrated, the Signature Edition mechanism and board assemblies become a matched set. Replacement of either requires pressure and rate calibration.

NOTE: Pay close attention to cable routing when disassembling the instrument. The cables are specifically routed to ensure they are not pinched or stressed when reassembled.

NOTE: No fluid in set for mechanical leak test.

NOTE: Ensure clamp is in the closed position.

NOTE: When air pressure is first applied a few bubbles are acceptable during mechanical leak check.

NOTE: Care should be taken to avoid applying too much tamper seal so it does not effect the transducer.

NOTE: There is one case screw inside battery compartment.

NOTE: If, as a result of the following calculation, the new rate cal value falls outside the range of 182 to 214, return the instrument to ALARIS Medical Systems or replace the mechanism.

NOTE: The disposable set (70RCS) cannot be used for more than 40 rate accuracy verification runs (20 rate cal number changes).

NOTE: If unit operation is at all doubtful, perform a complete PM procedure. This table provides minimum test requirements.

NOTE: Steps listed are in order of actions to take to correct problem/fault.

NOTE: Mechanism and boards can only be replaced in 7100E/7200E (or later) instruments.

NOTE: Record alarm history using the Alarm or History Error mode described in Section 6.4.3 "Viewing Alarm or Error History" before disconnecting the battery, disassembling, troubleshooting, or testing the pump.

NOTE: Pressing undo or cancel will undo any edits made to that page, and stay on the page. Pressing ok will accept all information on the page, and progress to another page in Diagnostic Mode.

NOTE: PM Due decrements with calendar time and is displayed to the nearest week.

NOTE: Pressing the Reset PM Due soft key resets the PM Due to the displayed PM Interval.

NOTE: If AC and battery power are disconnected from the instrument, alarm and error history may be lost.

NOTE: The only situation that the clock will not run is on loss of power. When viewing the alarms, the time will not be updated until exiting this page.

NOTE: Battery voltage will flash when updated by software.

NOTES: See Chapter 3 for specific rate accuracy verification testing. If the rate verification fails, see chapter 5 for rate calibration procedure with software 2.02 and higher.

NOTE: Battery is rated at 1.8 Ah under ideal conditions. 1.3 Ah will be entered here to help compensate for uneven cell capacity and ensure getting a "low battery alarm" with 30 minutes or more use on battery.

NOTE: The ID Number can be up to 9 digits.

NOTE: When the ON/OFF key is pressed while pump is on, it will display "Press and hold key to turn off".

NOTE: The hard cal procedure is in Chapter 5.

NOTE: Perform TEMP CAL message means TC≠0.0 in Adjust Tc Section. This may occur when main board is replaced.

NOTE: Measured Tc may be all dashes or show a number. Selected Tc must be 0.0 if software is 2.02 and higher.

NOTE: Selected Tc=0.0 with software is 2.02 or higher. If not, will get Perform Temp Cal message when in pressure calibration (soft).

NOTE: As a result of continuing product development, the part number you receive may not match the one you requested, but will be interchangeable, unless otherwise noted.

1.8.2 Cautions

CAUTION: Use only ALARIS Medical approved batteries due to Battery Manager requirements and the thermostat contained in the battery assembly.

CAUTION: Dispose of or recycle battery following hospital protocol. Refer to your institution's operating procedures, your state's EPA guidelines for disposal of battery or contact Rechargeable Battery Recycling Corporation (RBRC) at 1-800-822-8837.

CAUTION: Keep latch closed when instrument is not in use.

CAUTION: When there is no AC power available, do not replace dead battery for the purpose of re-powering the instrument. The instrument will not operate unless it is first connected to AC power after battery replacement.

CAUTION: Alcohol will cause the key pad to crack over time.

CAUTION: Do not connect ground resistance probe to pressure transducer.

CAUTION: To avoid serious damage to the board assemblies, use extreme care and always use proper static grounding techniques.

CAUTION: Do not mix mechanisms in dual channel or with other instruments. When a mechanism is removed, it must go back in the original position or the pump will need hard and soft pressure calibration as well as rate calibration.

CAUTION: Use only ALARIS Medical approved batteries due to Battery Manager requirements and the thermostat contained in the battery assembly

1.8.3 Warnings

WARNING: *When an instrument's configuration is changed, the configuration name should also be changed to document the new parameter settings. The intent of the configuration name is to have only one set of parameters for each alpha-numeric code. Refer to Section 2.5.2 "Pop-Up Displays"*

WARNING: *Powering down in configuration mode during an alarm or error will not save any configuration changes.*

WARNING: *Failure to perform regular and preventive maintenance inspections may result in improper instrument operation.*

WARNING: *Turn the instrument off and unplug the power cord from the AC wall outlet before cleaning. Do not steam autoclave, EtO sterilize, immerse the pump, or allow fluids to enter the pump case.*

WARNING: *Disconnect pump from AC power before disassembling. Hazardous voltages are present when AC power is connected regardless of the setting of the ON/OFF switch.*

WARNING: *Always perform a rate accuracy verification after mechanism and board have been removed and reinstalled or cables have been disconnected and reconnected.*

WARNING: *Use extreme caution in servicing the instrument when connected to AC power Hazardous voltages are present when AC power is connected regardless of the setting of the power switch.*

Table 1-2 Common Abbreviations

*	"active Low" logic signal
A	ampere
A/D	analog to digital converter
A/R	as required
AC	alternating current
Ah	ampere-hour
AIL	air-in-line
cm	centimeter
cmH2O	centimeters of Water
CMOS	complimentary symmetry metal oxide semiconductor
COML	commercial
°C	degrees celsius
D/A	digital to analog
DC	direct current
die	diameter
DIP	dual in-line package
EEPROM	electrically erasable programmable read-only memory
ELECT	electrolytic capacitor
EMI	electromagnetic interference
EPROM	erasable programmable read-only memory
ESD	electrostatic discharge
EtO	ethylene-oxide gas
°F	degrees fahrenheit
FET	field-effect transistor
ft	foot
H	hexadecimal
Hex	hexagonal
Hg	mercury
hr	hour
Hz	hertz
IC	integrated circuit
ID	inside diameter
in	inch
I/0	input/output
IV	intravenous
Js	jack
kg	kilogram
kHz	kiloHertz
kV	kilovolt
KVO	keep vein open
kΩ	kilohm
kW	kilowatt
lb	pound
LCD	liquid crystal display
LED	light emitting diode
lg	long
MHz	megahertz
µA	microamp
µF	microfarad
µsec	microsecond
mA	milliampere
min	minute
ml	milliliter
mm	millimeter
mmHg	millimeters of mercury
MOS	metal oxide semiconductor
ms	millisecond
MUX	digital multiplexer
N/A	not applicable
NPN	negative-positive-negative
no.; nos.	number or numbers
NU	not used
OD	outside diameter
Ω	Ohm
P/N	part number
PCB	printed circuit board
pF	picofarad
PNP	positive-negative-positive
PR	power regulator
psi	pounds per square inch
psig	psi-gauge
PWB	printed wiring board
r m s	root mean square
R/R	remove/replace
RAM	random access memory
RFI	radio frequency interference
ROM	read-only memory
SCR	silicon controlled rectifier
sec	second
SIP	single in-line package
SMD	surface mount device
S/N	serial number
SSD	static sensitive device
TANT	tantalum capacitor
thk	thick
TTL	transistor-transistor logic
V	volt
VAC	volts alternating current

Table 3 Reference Designators

C	capacitor
CR	diode/zener diode
DS	display
F	fuse
FB	ferrite bead
J	connector, terminal header
L	inductor
P	plug connector
Q	transistor/FET
R	resistor
RESN	ceramic resonator
S	switch
SPKR	speaker
T	transformer
TH	thermistor
U	integrated circuit
XU	socket for IC
Y	crystal
▽	ground

Table 4 Symbol Definition

	Attention, consult accompanying documents.
	RS-232 Connector
	Nurse Call

1.9 Compliance To Standards

The standards used as guidelines (at current revision level of public availability) in the design and development of the pump are as follows:

1.9.1 710X/720X

UL 544, "Standard for Medical and Dental Equipment"

CSA C.22.2 No. 125, "Safety Standards for Electro-medical Equipment"

AAMI ID26, "Standards for Infusion Devices".

FDA MDS 201-0004, "Electromagnetic Compatibility Standard for Medical Devices".

CISCR 11, "Limits and Methods of Measurement of Electromagnetic Disturbance Characteristics of Industrial, Scientific, and Medical (ISM) Radio Frequency Equipment".

IEC 529, 1989, "Classification of Degrees of Protection Provided by Enclosures".

IEC 801-2, "Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 2: Electrostatic Discharge Requirements".

IEC 801-3, Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3: Susceptibility to Radiated Electromagnetic Energy.

IEC 801-4, Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 4: Electrical Fast Transient/Burst Requirements".

IEC 801-5, Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 5: Voltage Surge Immunity Requirements".

FCC Docket 20780 Part 15 (Class A) Accessories with Information on Sets and Set Materials.

NAFTA 99, "Standards for Health Care Facilities.

1.9.2 Declaration of Conformity (7101/7201)

— DECLARATION OF CONFORMITY —
TO
MEDICAL DEVICES DIRECTIVE 93/42/EEC

Manufacturer: *ALARIS Medical Systems, Inc.*

Address: *10221 Wateridge Circle Drive*
San Diego, CA 92121-2733

Device: *Model 710X/720X Family Infusion Pumps and associated sterile IV administration sets.*

Device Options: *Model 180 Flow Sensor w/Flow Sensor Handle Cap*

We herewith declare that the above mentioned device(s) and accessories comply with the requirements of the EC Directive 93/42/EEC, that the conformity assessment procedures are completed, and the device(s) is designed, manufactured, and tested in accordance with the information contained within the Technical File.

This declaration is based on:

Annex II of EC Directive 93/42/EEC, EC Declaration of Conformity
Certification of Quality System
Certification Number: 0526
Issued By: British Standards Institution
Date: 27 June 1995

Device Technical File
Completed By: Quality Engineering
Initial Release Date: 1 July 1997

Supplementary Information

The product herewith has additionally been assessed and complies with the following specifications and standards:

Safety:
- IEC 601-1:1988/BS 5724:Part 1: 1989 "Safety of Medical Electrical Equipment"
- Draft IEC 601-2-24: Part 2 "Particular Requirements for Safety of Infusion Pumps and Controllers"

EMC:
- EN 55011: 1991
- EN 60601-1-1: 1993
- Draft IEC 60601-2-24 "Applicable EMC Limits"

Authorized EU Representative:
ALARIS Medical Systems, Inc.
Tony Thorne, Manager, International QA/RA
Intec 2 Wade Road
Basingstoke, UK
Hants
RG24 8NE

Issued by:
V.P. Quality and Regulatory,
ALARIS Medical Systems, Inc.
San Diego, California U.S.A.

Chapter 2 — CHECKOUT AND CONFIGURATION

CAUTION: Keep latch closed when instrument is not in use.

2.1 Introduction

This chapter describes the initial setup and configuration of the instrument. Included in this chapter is a reproducible form (Record of Configured Instruments, Table 2-3) available for recording and tracking configurations for instruments located in different areas. For your reference, a fold-out map of all the configuration screens is provided at the end of this chapter.

2.2 New Instrument Checkout

Refer to the instrument's Directions For Use (DFU) manual for instructions regarding unpacking and setting up the instrument for the first time.

When turning on the instrument, verify that the instrument beeps and that all display LED segments flash. This confirms that the pump has performed its self test, and is operating correctly. During operation, the pump continually performs a self test, and will alarm and display a message if it detects an internal malfunction.

Service is required if the pump fails to satisfactorily pass the start-up sequence. Refer the instrument to qualified service personnel if the instrument shows physical damage, is out of calibration, fails to complete the self test, or continues to alarm. Information about instrument alarms is found in Chapter 6 of this manual and in the Directions For Use.

For new instrument checkout, the minimum checks are:

- Functional Test (Chapter 3)
- Ground Current Leakage Test (Chapter 3)
- Flow Stop Test (Chapter 3)
- Instrument Configuration (Chapter 2)
- Rate Verification (Chapter 3)
- Pressure Verification (Chapter 3)
- Set Sensor Check (Chapter 3)

Table 2-1. Configuration Options and Defaults**

FEATURES	OPTIONS		FACTORY DEFAULTS	
	7100/7200	*7101/7201*	*7100/7200*	*7101/7201*
Air-in-Line:				
Threshold	50, 100, 200, or 500 µl	50, 100, 200, or 500 µl	100 µl	100 µl
Reset	On/Off	On/Off	Off	Off
Audio:				
Volumes	Low/Med/Hi, Med/Hi, Hi	Low/Med/Hi, Med/Hi, Hi	Low/Med/H	Low/Med/Hii
Transition Tone	On/Off	On/Off	On	On
AUTO ZERO: *(Set in Diagnostics Mode)*	On/Off	On/Off	Off	Off
Computer Link:				
Mode	Ctrl/Mntr/Off, Mntr/Off, Off	Ctrl/Mntr/Off, Mntr/Off, Off	Off	Off
Baud Rate	300/600/1200/1800/2400/4800/9600	300/600/1200/1800/2400/4800/9600	9600	9600
Parity	Even/Odd/None	Even/Odd/None	None	None
Dose Rate Drugs:				
Extended List Access	Short/Extended/Off		Off	
Drug ?	Short/Extended/Of	Drug ? (only)	Short	Drug ? (only)
Drug Specific Access*	Short/Extended/Off		Off	
Dynamic Monitoring:				
Mode	Hi Resist./Resist/Pressure	Hi Resist./Resist/Pressure	Pressure	Resistance
Display	On/Off	On/Off	On	On
Restarts	0 (Off), 1 to 9	0 (Off), 1 to 9	3	3
Alert(%)	On/Off (% in 5% increments)	On/Off (% in 5% increments)	Off	Off
Instrument ID: *(Set in Diagnostics Mode)*	9 digits	9 digits	Serial Number *(Factory Set)*	Serial Number *(Factory Set)*
Config Name:	4 alpha-numeric characters	4 alpha-numeric characters	IVAC	IVAC
KVO Rate:	0.1 to 20.0 ml/h	0.1 to 20.0 ml/hr	5.0 ml/hrr	5.0 ml/hr
Languages:	English, Canadian French	English, French, German, Dutch, Italian, Swedish, Spanish	English.	English
LCD Contrast: *(Set in Diagnostics Mode)*	1 to 256	1 to 256	127	127
Maximum Rate:	0.1 to 999.9 ml/hr	0.1 to 999.9 ml/hr	999.9 ml/hr	999.9 ml/hr
Optional Features:				
Panel Lock	On/Off	On/Off	On	On
VTBI	On/Off *(requires optional flow sensor)*	On/Off *(requires optional flow sensor)*	On	On***
Resistance Trend (Graph)	On/Off	On/Off	On	On
Multi-Dose Alert	On/Off	On/Off	Off	Off
Optional Modes:				
Loading Dose	On/Off	On/Off	On	On
Dose Rate	On/Off	On/Off	On	On
Multi-Step	On/Off	On/Off	Off	Off
Multi-Dose	On/Off	On/Off	Off	Off
Periodic Maintenance:				
(Set in Diagnostics Mode) Reminder	On/Off	On/Off	On	On
Interval	1 to 52 weeks	1 to 52 weeks	52 weeks	52 weeks
Self-Check Timer: *(Set in Diagnostics Mode)*	1 to 52 weeks	1 to 52 weeks	12 weeks	12 weeks
Set Time: *(Set in Diagnostics Mode)*	MO/YR/HR/MIN	MO/YR/HR/MIN	JAN 1, 1970 00:00	JAN 1, 1970 00:00

* *SEE TABLE 2-2*
** *Revision 2.44 Software and above.*
*** *Has Flow Sensor Board*

2.3 Start-Up Defaults

A hospital biomedical technician has the capability to set all configuration parameters to their start-up defaults in a single operation. The terms "configuration parameters" and "programmable features" are interchangeable and have the same meaning. Refer to Table 2-1. "Configuration Options and Defaults" for the instrument's options and initial factory start-up defaults.

2.4 Configuration Procedure

The configuration procedure is for use by qualified service personnel only. The configuration mode is intended for programming the technical and clinical features in accordance with your institution's current procedures and practices. Default values are listed in Table 2-1. "Configuration Options and Defaults".

Record the instrument configuration settings using Table 2-3. "Record of Configured Instruments".

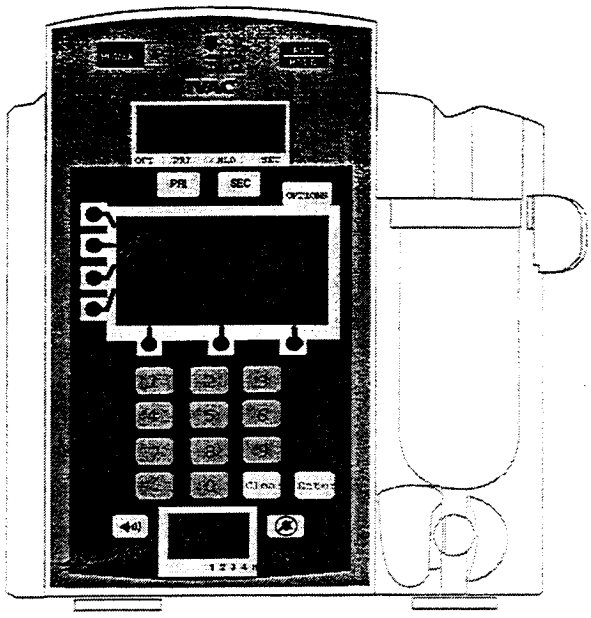
A fold-out map of all the configuration screens is located at the end of this chapter (Figure 2-1).

Pressing a soft key at the side of the main display the first time selects it for editing. Some features are edited by subsequent presses of the soft key to cycle through available options. Other features are edited by means of the numeric keyboard entry.

Pressing **undo** will undo any edits made to that page, and stay on the page. Pressing **ok** will accept all information on the page, and return to menu page.

Pressing POWER switch after editing a configurable item will evoke an invalid key tone and a message to "**ok entry**". You must OK your edit before you can power off instrument.

NOTE: The instrument's configuration information is not lost when disconnected from AC power and battery power. However, error history and infusion program settings may be lost. If you want to save this information be sure to record before disconnecting power.



WARNING: *When an instrument's configuration is changed, the configuration name should also be changed to document the new parameter settings. The intent of the configuration name is to have only one set of parameters for each alpha-numeric code. Refer to Section 2.5.2 "Pop-Up Displays"*

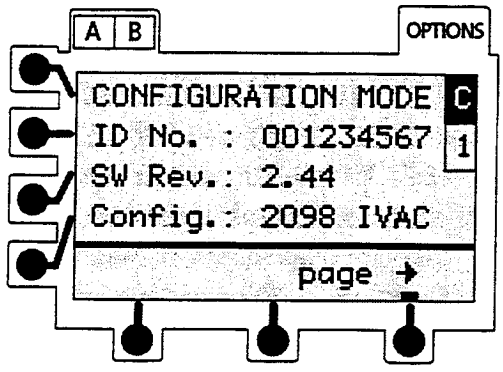
WARNING: *Powering down in configuration mode during an alarm or error will not save any configuration changes.*

2.4.1 Entering Configuration Mode

The instrument must be off (both channels must be off for Model 7200 instruments).

The procedure for the single and dual channel pump is the same. Any configuration in the dual channel pump sets the same value for both channels.

1. Press and hold the left-bottom display soft key.
2. Press and release POWER switch. Continue to press the display soft key until the configuration mode display appears, then release.
3. Page C1 (notice C1 in the upper right corner of the display) of the configuration mode is displayed. This is a read only display. Press **page→** to advance to the page you want to configure.



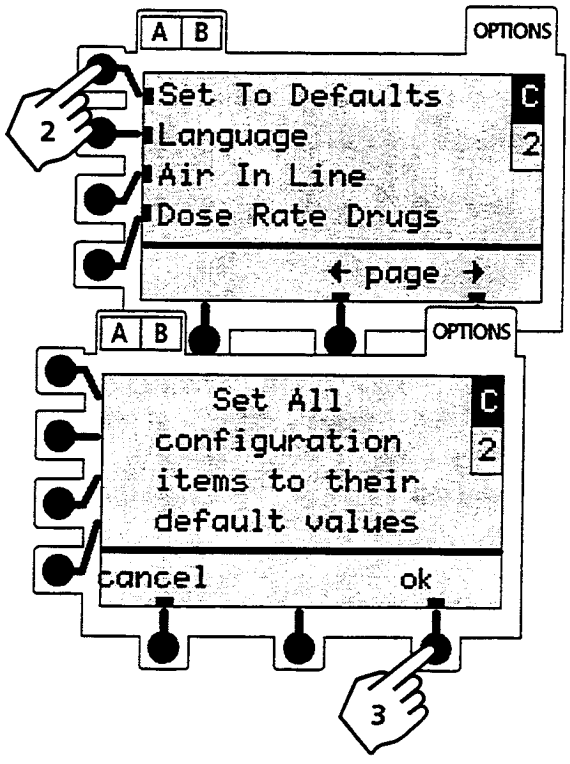
NOTE: FOR 7101X/7201X the default code will be 5B44 for instruments set to factory defaults (instead of 2098)

2.4.2 Setting to Defaults

The Set To Defaults Mode programs all configuration items to their default values.

NOTE: It is strongly recommended that you review Table 2-1 for a complete list of defaults before using this feature.

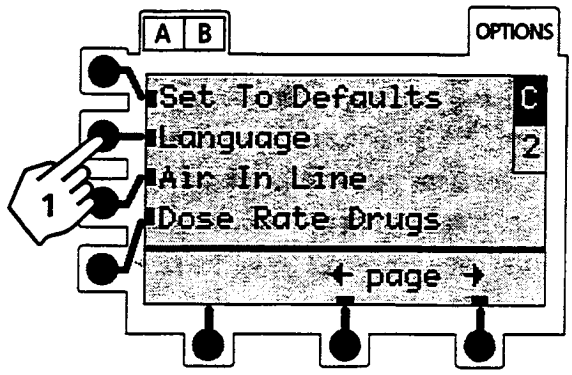
1. Advance to the C2 page (notice C2 in the upper right corner of the display).
2. Press **Set to Defaults** soft key.
3. Press **ok** to accept the change and return to the beginning of the C2 page. Pressing **Cancel** will leave all items set to their previous values and return to the beginning of the C2 page.

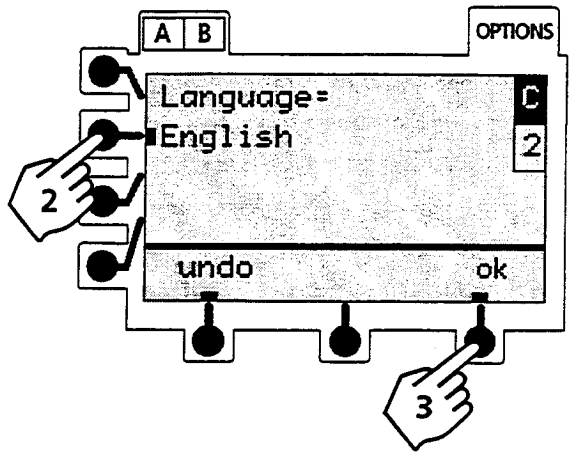


2.4.3 Setting Language

The language choices are English and Canadian French. All operating displays will be in the language selected. Diagnostic and configuration modes, however, will remain in English.

1. From the C2 page, press the **Language** soft key.
2. Press and release the soft key to select for editing. Press again to cycle between English and Canadian French for Models 7100/7200. For Models 7101/7201 the language choices are English, French, German, Dutch, Italian, Swedish and Spanish.
3. Press **ok** to accept the change and return to the beginning of the C2 page.



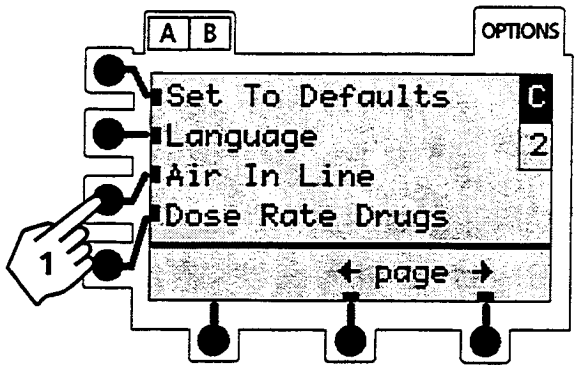


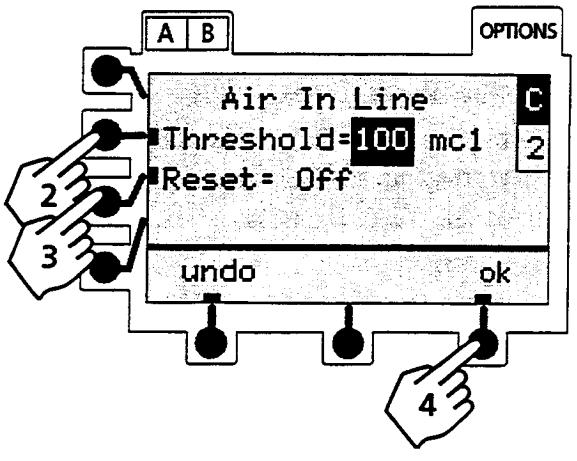
2.4.4 Setting Air-in-Line Threshold

The air-in-line threshold sets the bubble size sensitivity. The air-in-line reset allows the clinician to respond to an air-in-line alarm, assess the clinical significance of the air, and choose whether or not to continue the infusion without removing the air. The reset feature only allows the current bubble to proceed without tripping an alarm. The air-in-line threshold value choices are: 50, 100, 200, and 500 microliters.

NOTE: Use 50 microliter setting on microbore tubing. Other settings may be used on macrobore tubing.

1. From the C2 page, press the **Air-in-Line** soft key.
2. Press and release the **Threshold** soft key to select for editing. Press again to cycle through 50 µl, 100 µl, 200 µl, and 500 µl.
3. Press and release the **Reset** soft key to select for editing. Press again to cycle between **On** and **Off**.
4. Press **ok** to accept the change and return to the beginning of the C2 page.





2.4.5 Setting Dose Rate Drugs

*NOTE: In Models 7101/7201, **Drug?** is used instead of a drug list option. There is no tick mark next to Dose Rate.*

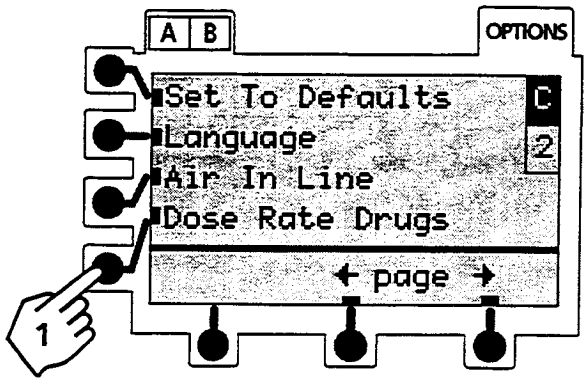
The Dose Rate Drugs feature allows the selection of a drug name to program a dose rate calculated infusion while in normal mode.

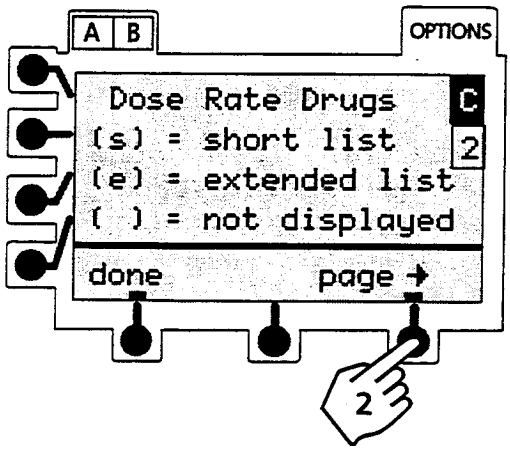
1. From the C2 page, press the **Dose Rate Drugs** soft key.
2. The introduction screen appears next. The introduction screen displays the legend used when selecting a drug. It is from this screen that you page forward to select a drug or select **done** to go to the Summary Page.

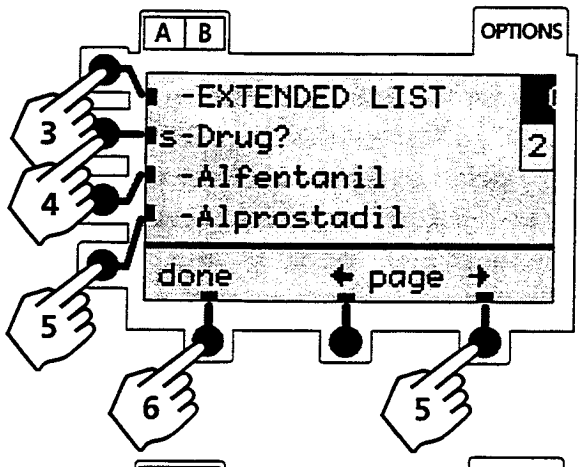
   Use the short list symbol "s" to select drugs that will appear in the short list. This is a convenient way to display frequently used drugs immediately in the normal drug selection process (startup mode, press options key).

   Use the extended list symbol "e" when selecting drugs to appear on the extended list. The extended list, if configured, provides a secondary list of drug names not normally used.

   Press **done** at any time to display the Summary Page. Press **page→** to advance to the next page.
3. Press and release the **Extended List** soft key to cycle between "s" and "blank". If "blank" is selected the Extended List will not be available.
4. Press and release the **Drug?** soft key to cycle between "s", "e", and "blank". Use "s" for commonly used drugs.
5. Press and release a soft key next to a drug to cycle between "s", "e", and "blank". Press **page→** to continue viewing the drug list. Refer to Table 2-2 "Drug List" to view full list of drug
6. Press **done** to display the Summary Page.
7. Press **review** to return to the introduction screen or press **ok** to accept the selections and return to the C2 page.







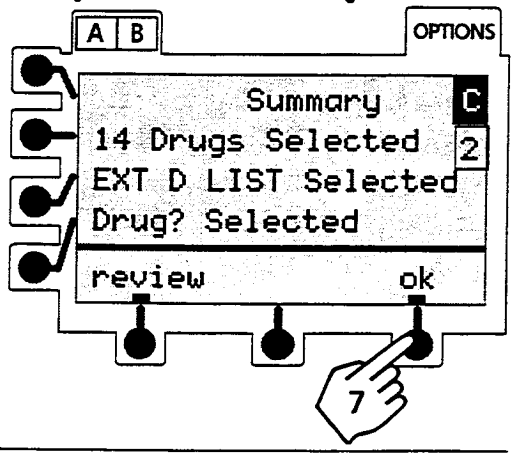


Table 2-2. Drug List *(7100/7200 only)*

Alfentanil (Alfent®)[1]

Alprostadil(Prostin®)[2] (PGE-1)

Alteplase (Activase®)[3]

Aminophylline

Amrinone (Inocar®)[4]

Atracurium (Tracrium®)[5]

Bretylium (Bretylol®)[6]

Cimetidine (Tagamet®)[7]

Diltiazem (Cardizem®)[8]

Dobutamine (Dobutrex®)[9]

Dopamine (Intropin®)[6]

Esmolol (Brevibloc®)[10]

Heparin

Isoproterenol (Isuprel®)[4]

Labetalol(Normodyne®)[11](Trandate®)[12]

Lidocaine (Xylocaine®)[13]

Magnesium Sulfate

Methylprednisolone

Milrinone

Morphine

Nitroglycerin (Tridil®)[6]

Nitroprusside (Nipride®)[14]

Norepinephrine (Levophed®)[4]

Oxytocin

Phenylephrine (Neo-Synephrine®)[4]

Potassium Chlor

Procainamide

Propofol (Diprivan®)[15]

Ranitidine (Zantac®)[16]

Streptokinase (Streptase®)[13]

Succinylcholine (Anectine®)[5]

Theophylline

Urokinase (Abbokinase®)[17]

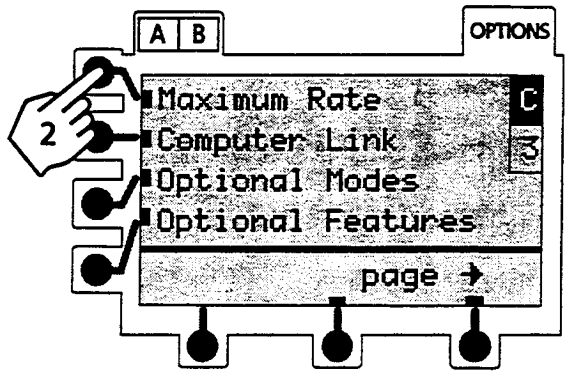
Vecuronium (Norcuron®)[18]

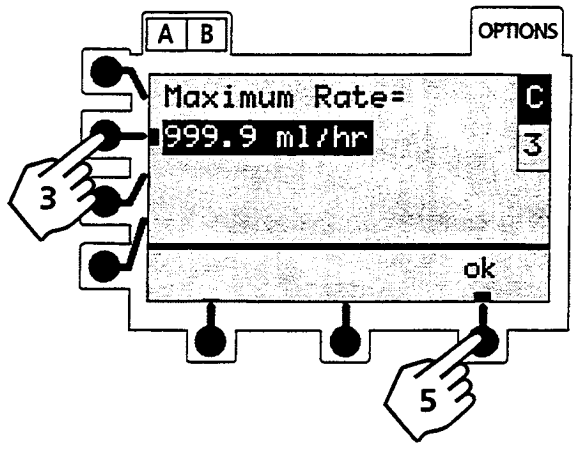
01 Janssen Parmaceutica Inc., 1125 Trenton-Harbourton Road, P.O. Box 200, Titusville, NJ 08560-0200
02 The Upjohn Company, Kalamazoo, MI 49001
03 Genentech, Inc., 460 Point San Bruno Blvd., South San Francisco, CA 94080-4990
04 Sanofi Winthrop Parmaceuticals, 90 Park Avenue, New York, NY 10016
05 Burroughs Wellcome Co., 3030 Cornwallis Road, Research Triangle Park, NC 27709
06 Du Pont Multi-Source Products, The Du Pont Merck Pharmaceutical Company, 1000 Stewart Avenue, Garden City, NY 11530
07 SmithKline Beecham Consumer Brands, L.P., Unit of SmithKline Beecham Inc., P.O. Box 1467, Pittsburgh, Pa 15230
08 Marion Merrell Dow Inc., 9300 Ward Parkway, P.O. Box 8480, Kansas City, MO 64114-0480
09 Eli Lilly and Company, Lilly Corporate Center, Indianapolis, IN 46285
10 Anaquest Inc., 110 Allen Road, Box 804, Liberty Corner, NJ 07938-0804
11 Schering Corporation, a wholly-owned subsidiary of Schering-Plough Corporation, Galloping Hill Road, Kenilworth, NJ 07033
12 Allen & Hansbury, Division of Glaxo Inc., Five Moore Drive, Research Triangle Park, NC 27709
13 Astra USA, Inc., 50 Otis Street, Westboro, MA 01581-4500
14 Elkins-Sinn, Inc., 2 Esterbrook Lane, Cherry Hill, NJ 08003-4099
15 Stuart Pharmaceuticals, A business unit of Zeneca Inc., Wilmington, DE 19897 USA
16 Glaxo Pharmaceuticals, Division of Glaxo Inc., Five Moore Drive, Research Triangle Park, NC 27709
17 Abbott Laboratories, Pharmaceutical Products Division, North Chicago, IL 60064, U.S.A.
18 Ohmeda Inc., Pharmaceutical Products Division, 110 Allen Road, Box 804, Liberty Corner, NJ 07938-0804

2.4.6 Setting Maximum Rate

This sets the maximum rate selectable by the clinician. The range for Maximum Rate is 0.1 to 999.9 ml/hr.

1. Advance to the C3 page.
2. Press **Maximum Rate** soft key.
3. Press and release soft key to select for editing.
4. Use the numeric keypad to enter the maximum rate. Press ENTER.
5. Press **ok** to accept the change and return to the beginning of the C3 page.





NOTE: Setting the Maximum Rate below the preset KVO Rate will lower the KVO Rate. The KVO rate will not exceed the Maximum Rate.

NOTE: The maximum rate setting applies to all infusion modes.

2.4.7 Setting Computer Link

The Computer Link feature allows a hospital computer to interact with the pump and programs the level of computer control available to the clinician. The computer cannot start or stop the pump, set the rate, or make any change in status. If the feature is off, the computer cannot communicate with the pump.

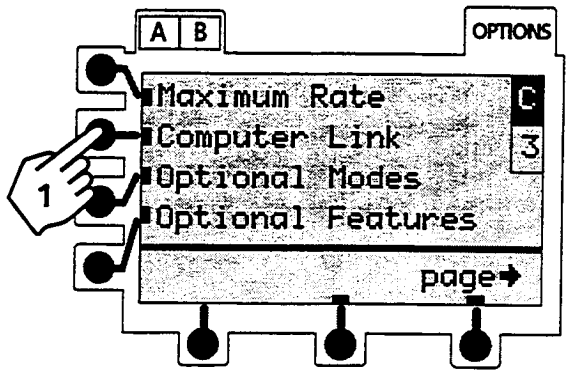
a. Control Mode: allows the computer to send information to the pump's display.

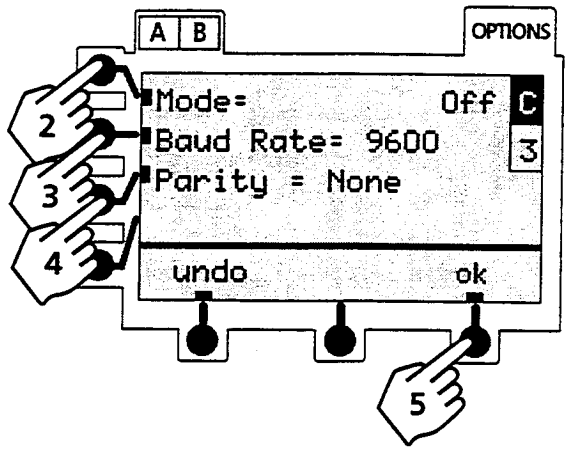
b. Monitor Mode: allows the computer to only receive information from the pump.

c. Off Mode: does not allow any communication between the pump and a computer.

Enabling of the monitoring and control modes will automatically place them in the user's options menu.

1. On the C3 page, press the **Computer Link** soft key.
2. Press and release **Mode** soft key to select for editing. Press again to cycle through **Off**, **Mntr Off**, and **Ctrl Mntr Off.**
3. Press the **Baud Rate** soft key to select for editing. Press again to cycle through choices (**300**, **600**, **1200**, **1800**, **2400**, **4800** and **9600**).
4. Press the **Parity** soft key to select for editing. Press again to cycle through **Even**, **Odd**, and **None**.
5. Press **ok** to accept the changes and return to the beginning of the C3 page.





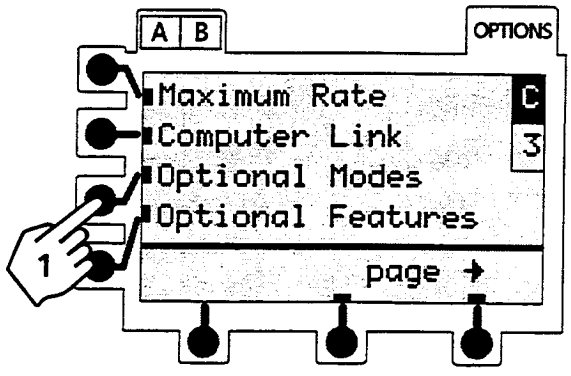
2.4.8 Setting Optional Modes

The Optional Modes feature allows the clinician to configure how the options menu will appear in normal mode. Enabling of these modes will automatically place them in the user's option menu.

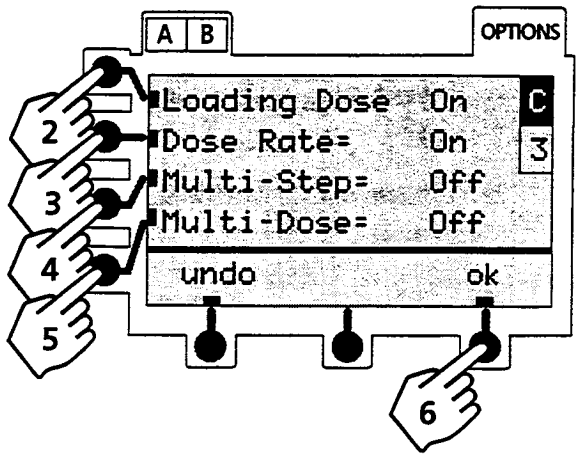
When Loading Dose, Multi-Step, and Multi-Dose are on, they appear in the menu when the options key is pressed in normal mode.

For Dose Rate to appear in the options menu, it must be turned on as well as something programmed in the drug short list. If anything is programmed for the drug short list, then the appearance of the Dose Rate in the options menu only requires that the Dose Rate feature be on.

1. On the C3 page, press the **Optional**



2. Press and release **Loading Dose** soft key to select for editing. Press again to cycle between **On** and **Off**. This feature allows the clinician to set up an initial infusion rate for a specific volume, automatically followed by a maintenance rate from the same container.
3. Press and release **Dose Rate** soft key to select for editing. Press again to cycle between **On** and **Off**. This feature allows the clinician to program dose parameters and the instrument calculates the volumetric rate.
4. Press and release **Multi-Step** soft key to select for editing. Press again to cycle between **On** and **Off**. This feature allows a sequential program to deliver up to nine steps; fluid volumes and delivery rates may be programmed for each step.
5. Press and release **Multi-Dose** soft key to select for editing. Press again to cycle between **On** and **Off**. This feature allows the clinician to pre-program multiple infusions over a period of up to 24 hours; the fluid volume and delivery rate is repeated for each delivery.
6. Press **ok** to accept the changes and return to the beginning of the C3 page.



2.4.9 Setting Optional Features

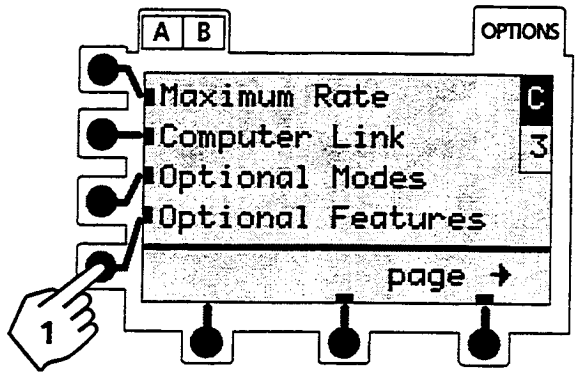
The Panel Lock feature allows the clinician to lock and unlock the front panel to help prevent tampering.

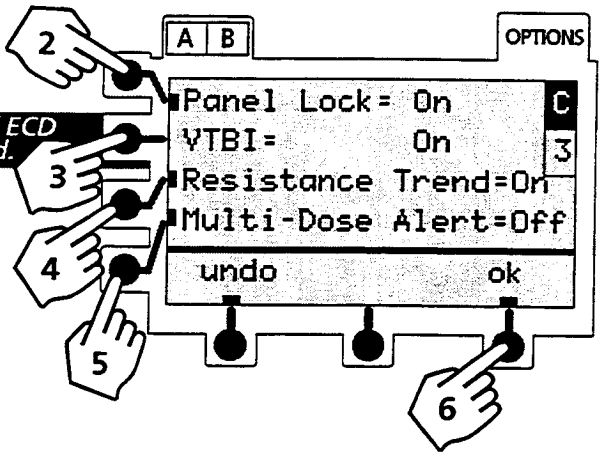
When VTBI (Volume To Be Infused) is on, the clinician must always enter a volume to be infused, otherwise the last remaining VTBI or last entered VTBI will be in effect depending on the channel's last usage. When VTBI is off there is no VTBI line capability to the user.

When the Resistance Trend feature is on, a graph is displayed on main LCD via Options Menu.

When the Multi-Dose Alert feature is on, the clinician will get the option to set an alert at the end of every dose when in Multi-Dose Mode.

1. On the C3 page, press the **Optional Features** soft key.
2. Press and release **Panel Lock** soft key to select for editing. Press again to cycle between **On** or **Off**.
3. Verify **VTBI** is on (need flow sensor option installed to be able to turn off).
4. Press and release the **Resistance Trend** soft key to select for editing. Press again to cycle between **On** or **Off**.
   a. In Pressure Only mode, the graph still displays Hi Resistance data.
   b. Trend data is lost when:
      - User clears graph information
      - Unit is off for more than 6 hours
      - Resistance Mode is changed
      - Resistance Mode is changed to Pressure Only Mode.
   c. Trend data is maintained when:
      - Pressure Only Mode is changed to/from Hi Resistance Mode.
      - Rate is changed
      - Unit is off for less than 6 hours.
5. Press and release the **Multi-Dose Alert** soft key to select for editing. Press again to cycle between **On** or **Off**.
6. Press **ok** to accept the changes and return to the beginning of the C3 page.





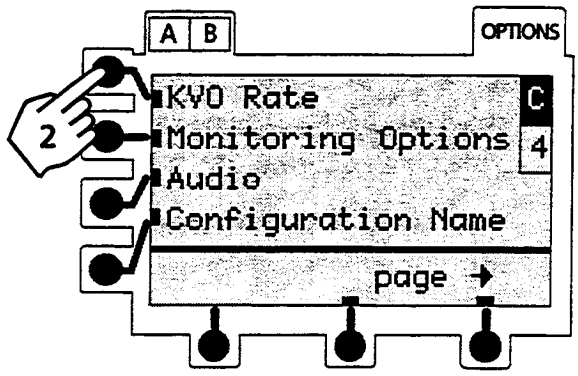
Accessible only if ECD option is installed.

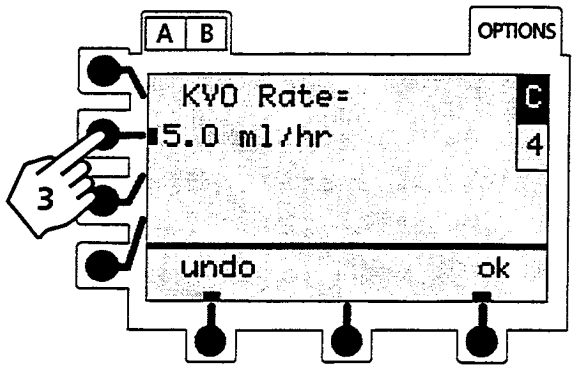
2.4.10 Setting KVO Rate

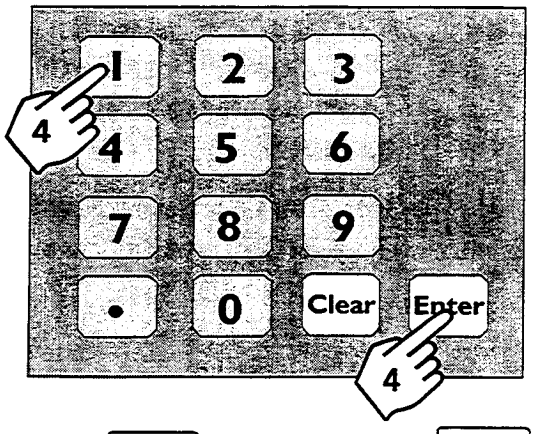
The pump will automatically operate at the KVO rate (or the current rate, whichever is less) once the primary VTBI has counted down to zero. The KVO rate range is 0.1 to 20.0 ml/hr.

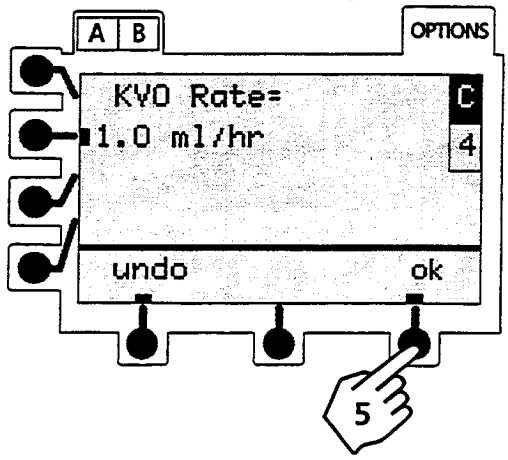
1. Advance to the C4 page.
2. Press KVO Rate soft key.
3. Press soft key next to rate value once to select for editing.
4. Use the numeric pad to enter the KVO rate. Press ENTER.
5. Press ok to accept the change and return to the beginning of the C4 page.

NOTE: The KVO rate will not exceed the present Maximum Rate.









2.4.11 Setting Monitoring Options

The graphical resistance display (appearing in the Main LCD) may be turned on or off. Turning the display off will also turn the resistance alert feature off.

The AutoRestartPlus™ feature allows the pump to automatically continue an infusion if a down-stream occlusion is cleared during the "re-check" period (40 seconds). A warning tone and display message will appear for 40 seconds. The feature can be turned off (set the restarts to zero), or the number of restarts may be set from 1 to 9.

NOTE: The restart counter is reset whenever the clinician presses Run/Hold, if the pump or channel is turned off, or if an alarm occurs.

A resistance alert feature may be turned on or off. If on, the hospital can set the desired alert level. The default alert level can be set from 5 to 100% in 5% increments. This is the initial value presented to the clinician; the clinician may reset the value to meet specific application needs.

1. On the C4 page, press the **Monitoring Options** soft key.
2. Press and release the **Mode** soft key to select for editing. Press again to cycle between **Hi Resist.**, **Resistance** and **Pressure Only**.
3. Press and release the **Display** soft key to select for editing. Press again to cycle between **On** and **Off**.

NOTE: If display is off, the alert feature will automatically be turned off.

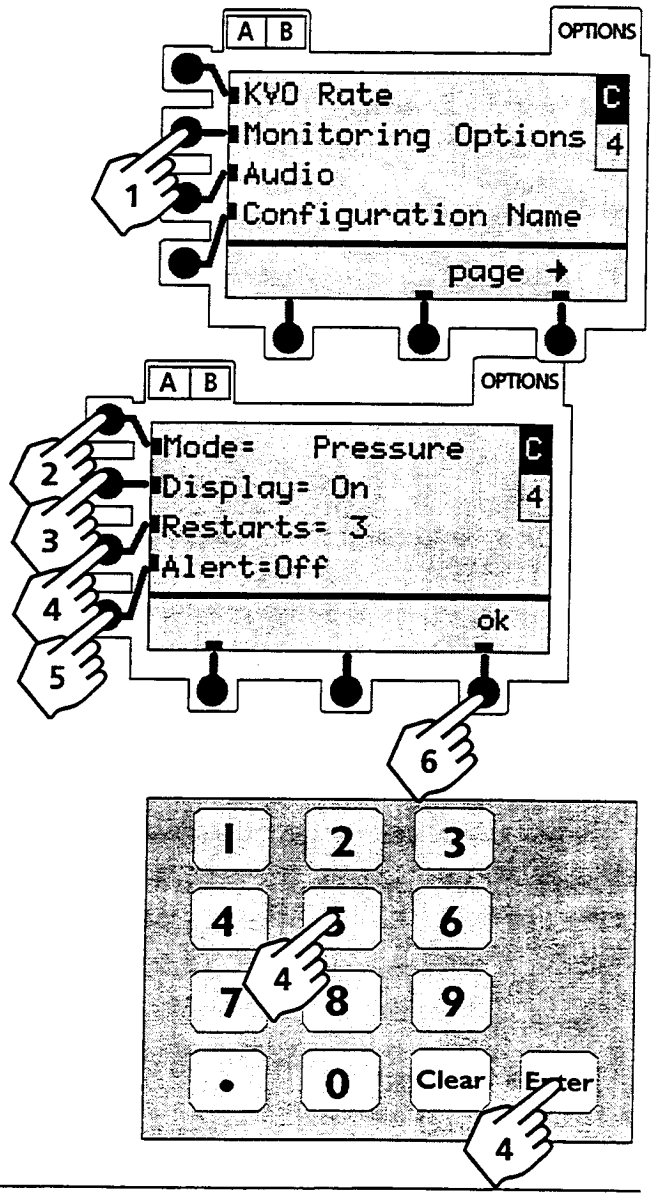
4. Press and release the **Restarts** soft key. Use the numeric keypad to enter the number of restarts from 0 (which turns the feature off) to 9, then press ENTER.
5. Press the **Alert** soft key. Press again to cycle between **On** and **Off**. If on, use the numeric keypad to enter the desired alert %. Press ENTER. The value will round to the nearest 5%.
6. Press **ok** to accept the changes and return to the beginning of the C4 page.

NOTE: Resistance trend graph data is lost when: 1) Clear is pressed, 2) Pump is off for more than 6 hours.

NOTE: Resistance measurement is restarted at 0% when: 1) Run/Hold is pressed to put on hold and again to start, 2) Dose ends in Multi-Dose mode, 3) Checking line message appears.

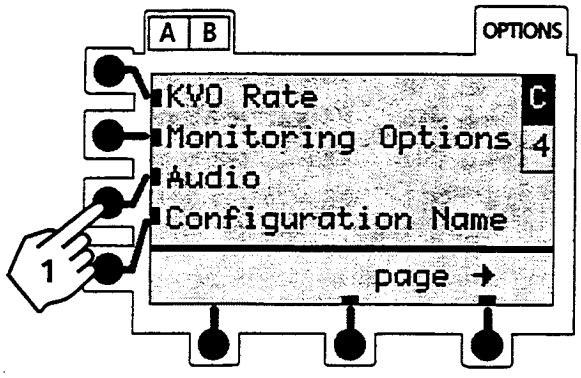
NOTE: Checking line alert applies to pressure, resistance and upstream occlusion with one tone at the beginning and a flashing popup display (on for 4 seconds, off for 6 seconds). No nurse call activation.

NOTE: Resistance alert will give an alarm tone every thirty seconds, with a popup display (on for 4 seconds, off for 6 seconds). Nurse call activated. This occurs when the resistance measurement is above the alert threshold or at 100% even when checking line.

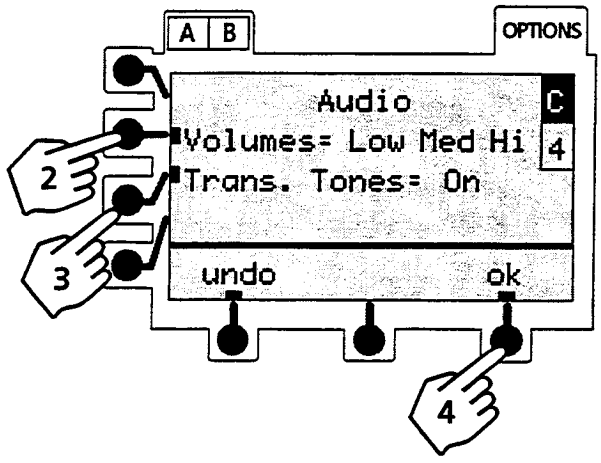


2.4.12 Setting Audio Volume

The volume settings determine which range of audio volume is available to the clinician. For example; "Low" may be too low for your institution, therefore you would choose "Med Hi". A transition tone, if enabled, will sound upon completion of a secondary VTBI, step in multi-step mode, dose beginning and ending in multi-dose mode, and completion of a loading dose in loading-dose mode. The speaker volumes are approximately: Low = 65 dB, Med = 70 dB, and Hi = 75 dB.



1. On the C4 menu, press the **Audio** soft key.
2. Press and release the **Volumes** soft key to select for editing. Press again to cycle between **Low/Med/Hi**, **Med/Hi**, or **Hi**.
3. Press the **Trans. Tone** soft key to select for editing. Press again to cycle between **On** and **Off**.
4. Press **ok** to accept the changes and return to the beginning of the C4 page.



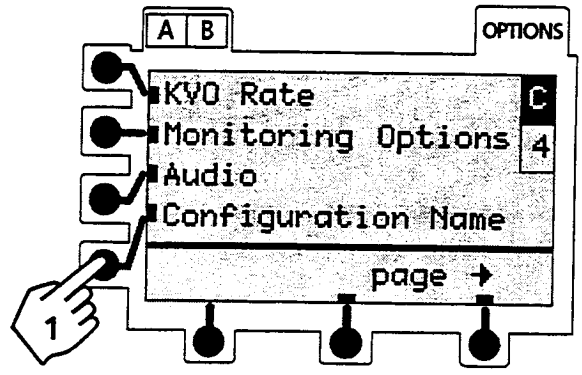
2.4.13 Setting Configuration Name (Instrument ID Label)

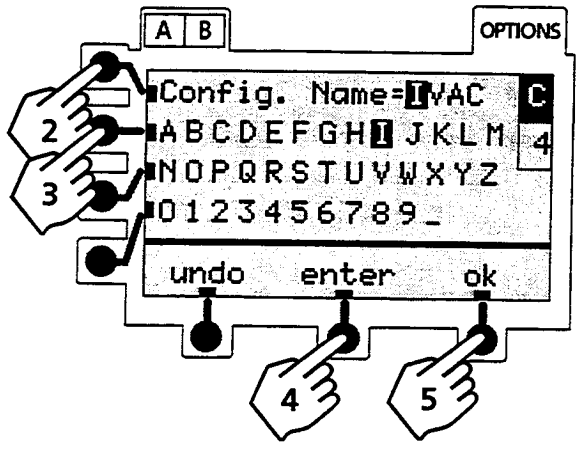
The characters entered here will be shown in the lower LCD display. This electronic label is normally displayed, even when the pump is off.

The configuration name can be used to uniquely identify the instrument's configuration, hospital location, or reference number. It is a 4 character alpha/numeric name, examples are: PICU (Pediatric Intensive Care Unit), ICU (Intensive Care Unit), or 2400.

NOTE: You will see a 4 digit alpha/numeric code next to the configuration name upon entering configuration mode. Refer to Section 2.4.1 "Entering Configuration Mode". This code is only a hexadecimal reflection of your instrument's configuration.

1. On the C4 menu, press the **Configuration Name** soft key.
2. Press and release **Config. Name** soft key to position the highlight on the character to be changed.
3. Press and release the character soft keys aligned with the rows A to M, N to Z, or 0 to _ to highlight the character you want.
4. Press **enter**. Up to four characters can be programmed in this way. Repeat steps 2,3,4 as necessary.
5. Press **ok** to accept the changes and return to the beginning of the C4 page.





NOTE: If you have changed the configuration but not the name, the pump will display the option to rename before turning off or proceeding to the teach mode. Refer to Section 2.5.2 "Pop-Up Displays" for further explanation.

NOTE: Must have 4 characters in configuration name, use space (-) symbol to fill in any open character.

2.5 Transferring Settings to Another Pump

Once a pump has been programmed to meet technical and clinical needs, the settings can be transferred to other pumps. The programmed pump is referred to as the "Teacher" and the other pump is referred to as the "Learner".

NOTE: Only the configuration settings will be transferred. The instrument ID number and the periodic maintenance settings from the diagnostics mode will not be transferred.

Connect a standard 9-pin Null Modem RS-232 cable (also available from ALARIS Medical Systems, P/N 133450) to the RS-232 ports on the pumps.

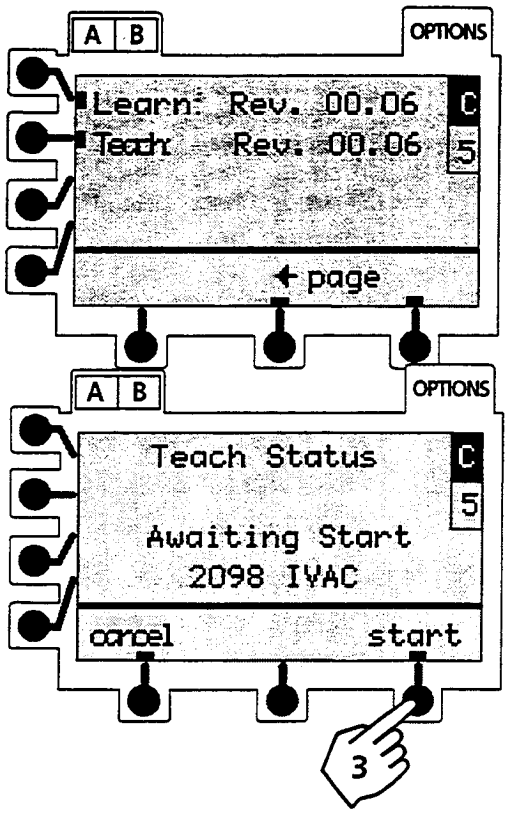
2.5.1 Teacher/Learner Pump Procedure

1. Access the Configuration Mode for both "teacher" and "learner" instruments and advance to page C5.
2. Press and release the **Teach** soft key of the "Teacher" instrument and press and release the **Learn** soft key of "Learner" instrument.
3. Press and release the **start** soft key of the "Teacher" instrument.

The pumps will display **Downloading** until the transfer is complete, then they will indicate if the transfer was successful or unsuccessful.

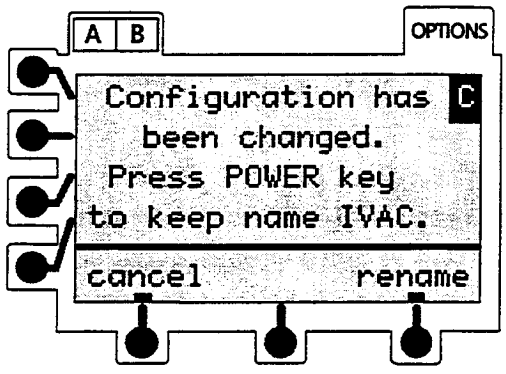
NOTE: **Repeat** *allows you to re-attempt or teach the next pump.*

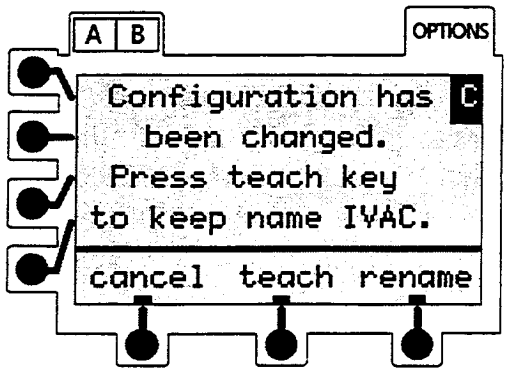
NOTE: The Learn/Teach function will not work if revision level is not the same on both pumps or if the pumps are not the same model (ie., 710x/720x to 7000A).



2.5.2 Pop-Up Displays

The pop-up screens appear when the user attempts to turn off the instrument or execute the teach mode after changing the configuration (or accessing a configured item) but not changing the configuration name. If you change the instrument's configuration and not the configuration name, you may have similarly named instruments but with different configurations. The pop-up menus ask you if you want to rename the configuration.





Duplicate the following table for additional entries.

Table 2-3. Record of Configured Instruments

	Serial #	Serial #	Serial #	Serial #	Serial #
*Instrument ID #					
Config Name (Instr Label)					
Location					
Language					
Air-in-Line: Threshold Reset	µl	µl	µl	µl	µl
Maximum Rate ml/hr	ml/hr	ml/hr	ml/hr	ml/hr	ml/hr
Computer Link: Mode Baud Rate Parity					
Optional Modes: Loading Dose Dose Rate Multi-Step Multi-Dose					
Optional Features: Panel Lock Resistance Trend Multi-Dose Alert					
KVO Rate ml/hr	ml/hr	ml/hr	ml/hr	ml/hr	ml/hr
Monitoring Options: Mode Display Restarts Alert					
Audio: Volume Trans. Tone					
*PM Reminder					
*PM Interval					

**Accessed through Diagnostic Mode. Refer to Section 6.4.1 "Entering Diagnostics Mode"*

RECORD OF CONFIGURED ALARIS Medical Systems SE INSTRUMENTS

Hospital: _____

Unit: _____

DRUG NAME/OPTION	TRADE NAME	NOT SELECTED	SHORT LIST	EXTENDED LIST
Extended List Access				
DRUG?				
Alfentanil	Alfenta®			
Alprostadil	Prostin® (PGE-1)			
Alteplase	Activase®			
Aminophylline				
Amrinone	Inocar®			
Atracurium	Tracrium®			
Bretylium	Bretylol®			
Cimetidine	Tagamet®			
Diltiazem	Cardizem®			
Dobutamine	Dobutrex®			
Dopamine	Intropin®			
Esmolol	Brevibloc®			
Heparin				
Isoproterenol	Isuprel®			
Labetalol	Normodyne®/Trandate®			
Lidocaine	Xylocaine®			
Magnesium Sulfate				
Methylprednisolone				
Milrinone				
Morphine				
Nitroglycerin	Tridil®			
Nitroprusside	Nipride®			
Norepinephrine	Levophed®			
Oxytocin				
Phenylephrine	Neo-Synephrine®			
Potassium Chlor				
Procainamide				
Propofol	Diprivan®			
Ranitidine	Zantac®			
Streptokinase	Streptase®			
Succinylcholine	Anectine®			
Theophylline				
Urokinase	Abbokinase®			
Vecuronium	Norcuron®			

Chapter 3 — PREVENTIVE MAINTENANCE

WARNING: *Failure to perform regular and preventive maintenance inspections may result in improper instrument operation.*

3.1 Introduction

To ensure the pump remains in good operating condition, regular and preventive maintenance inspections are required. Regular inspections are not covered under any contract or agreement offered by ALARIS Medical Systems and must be performed before each use of the instrument by the user.

Use Table 3-1 "PM Inspections" to record the completion of preventive maintenance inspections. These inspections should be performed yearly or as indicated by qualified technician or biomedical engineer.

The preventive maintenance inspections listed are recommended at a one year interval and should be performed in accordance with ALARIS Medical Systems requirements and guidelines. A maintenance reminder will occur after 52 weeks, unless the feature has been changed to select a different time interval or has been disabled. These inspections are also intended to complement the intent of JCAHO requirements, and are not covered by the ALARIS Medical Systems warranty.

In the United States, a service agreement may be obtained from ALARIS Medical Systems for the performance of all required preventive maintenance inspections.

3.2 Storage and Cleaning

3.2.1 Storage

The pump may be stored without connection to AC power. It will automatically disconnect the battery when the voltage gets too low. To reuse the pump after storage, connect it to AC power for a minimum of three (3) hours before placing it back into service. When temporarily taking instrument out of service, connect it to AC power to ensure a fully charged battery when needed.

3.2.2 Cleaning

It is good practice to routinely clean the pump, especially if spillage has occurred.

Do not use solutions containing phosphoric acid (Foamy Q&A[1]) or aromatic solvents (naphtha, paint thinner, etc.), chlorinated solvents* (Trichloroethane, MEK, Toluene, etc.) or alcohol.

CAUTION: Alcohol may cause the key pad to crack over time.

Do not use hard or pointed objects to clean any part of the pump.

Do not steam autoclave, EtO sterilize, or immerse the pump.

WARNING: Turn the instrument off and unplug the power cord from the AC wall outlet before cleaning. Do not steam autoclave, EtO sterilize, immerse the pump, or allow fluids to enter the pump case.

Acceptable cleaning solutions are (Use per manufacturer's instructions):

Warm Water
Vesphene®IIse [1]
CompuBlend™II [2]
Virex*II 256[3]
Manu-Klenz® [1] *(cleaning only)*
10% Bleach Solution *(1 part bleach to 9 parts water)*

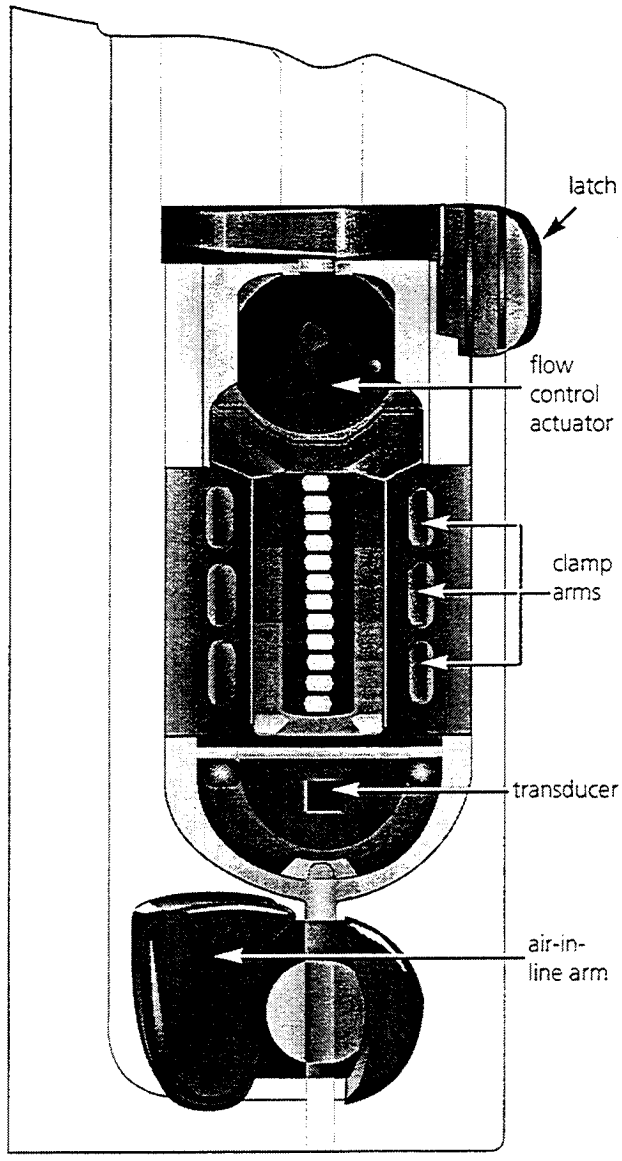
a. Place instrument on drain board or other surface above sink. Keep instrument upright and do not allow any part of the instrument to become submersed in water during the cleaning operation.

b. Use a soft cloth dampened with warm water and a mild non-abrasive cleaning solution to clean all exposed surfaces. For sanitizing or anti-bacterial treatment, use 10% bleach solution and water.

- A soft-bristled brush may be used to clean hard to reach and narrow areas.
- Use light pressure when cleaning the pressure transducer and air-in-line detector areas of the pumping channels. Refer to "Cleaning the Mechanism Area".
- Move latch to open and closed positions as required to clean behind latch and air-in-line arm.

c. No additional lubrication should be necessary.

Figure 3-1 Cleaning the Mechanism Area



Clean in and around the latch.

Clean the flow control actuator.

Clean in and around the clamp arms and pumping mechanism.

Use light pressure when cleaning the pressure transducer.

Use light pressure when cleaning the air-in-line detector.

Clean in and around the air-in-line arm.

* *excluding 10% bleach solution in water.*
[1] *Calgon Vestal Laboratories, Division of Calgon Corporation, Subsidiary of Merck & Co., Inc.*
[2] *3M Healthcare, Subsidiary Building Service & Cleaning Products, a Division of 3M.*
[3] *This is a trademark of Building Service & Cleaning Products, a Division of 3M.*

3.3 Preventive Maintenance Inspections

A message can be set through the diagnostics mode which automatically reminds the user when preventive maintenance inspections are due. Refer to Section 6.4.2 "Setting Preventive Maintenance Interval" for setting the inspection interval.

3.3.1 Regular Inspection

Regular inspections consist of a visual inspection for damage and cleanliness, and performing the procedure described in the Start Up Sequence Section of the Directions For Use manual before each usage of the instrument. Regular inspections are not covered under any contract or agreement offered by ALARIS Medical Systems and must be performed by the user.

Case

Examine the unit for overall condition. The case should be clean and free from IV solution residue, especially near moving parts. Also check for dried solution deposits on accessible areas of air-in-line sensor, pressure transducer, and latch mechanism. Check that labels and markings are legible.

Mounting Bracket

Pole mounting bracket should be secure and functioning. If the instrument is mounted on a pole or stand, examine the condition of the mount. Also, examine the pole and stand.

Power Cord Assembly

Examine the power cord assembly for:

a. Signs of damage, cuts or deformities in the cord. If damaged, replace the entire cord.

b. Integrity of hospital grade power plug. Attempt to wiggle the blades to determine that they are secure. If any damage is suspected, replace the entire cord.

c. Appropriate tension and connection if the IV pole has electrical receptacles for accessories.

d. Strain reliefs. Examine the strain reliefs at both ends of the line cord. Be sure they hold the cord securely.

Keypad

Check membrane switches for damage; e.g., from fingernails and pens. During the course of the inspection, be sure to check that each switch performs its proper function. Refer to Section 6.4.15 "Testing Switches".

Mechanism

Clean any surfaces where solution or obstructions have accumulated. Verify that:

a. The mechanism seal is not torn or worn.

b. The cam followers are not broken or cracked and are free of foreign matter.

c. Proper operation of latching mechanism. Cam followers should retract and extend smoothly.

d. Air-in-line arm moves smoothly from opened to closed position.

e. Fluid Control Actuator rotates 180°.

3.3.2 Functional Test

a. Turn instrument on without set installed. Verify that it "beeps" and red alarm light flashes.

b. Set infusion rate to 460 ml/hr and VTBI to 100 ml.

c. Press the RUN/HOLD switch with the latch closed, and rate and VTBI ≠ 0 to cause a "set out" and "air in line" messages.

d. Open the latch.

e. Install primed administration set with latch open.

f. Verify the pump displays "air in line" and "latch open" messages.

g. Close the latch and verify the display returns to the setup page.

h. Perform upstream occlusion test as follows:

1. Verify the infusion rate is set to 460 ml/hr.

2. With the pump on hold, or at start-up, verify the primary VTBI is set to 100.

3. Press the RUN/HOLD switch to begin the infusion.

4. Clamp off IV line just above pump to simulate an upstream occlusion. Verify the pump stops running, alarms, and displays OCCLUSION UPSTREAM within 60 seconds.

5. Press the RUN/HOLD switch to silence the alarm and put the pump on hold.

6. Remove or open the clamp on the line.

7. Press the RUN/HOLD switch to resume infusion. The alarm should not reoccur.

i. Perform downstream occlusion test as follows:

1. Continue pumping from above step.

2. Verify rate is set to 460 ml/hr. Clamp off the set just below the pump.

3. Allow pump to run until it alarms OCCLUSION DOWNSTREAM within 60 seconds.

4. Press the RUN/HOLD switch to silence the alarm and put the pump on hold.

5. Release or open clamp.

6. Press the RUN/HOLD switch to resume infusion. The alarm should not reoccur.

3.3.3 Flow Stop Test

a. Turn the power off with the administration set primed and loaded in the instrument.

b. With all tubing clamps open and the fluid container two or more feet above the device, verify that no fluid flows out of the set.

c. Remove set. Verify that no fluid flows out of the set.

3.3.4 Rate Accuracy Verification Test

Refer to Figure 3-2 "Setup for Rate Verification Test".

NOTE: Due to the Dynamic Monitoring feature, the rate is varied during operation. For this reason, ALARIS Medical Systems does not recommend using automatic testers to check rate accuracy. Generally, these devices collect small samples and may cause the results to be incorrect even though the instrument is accurate.

NOTE: Do not use 70RCS more than 40 times.

a. Fill the solution container with clean tap water. Take a 70 RCS rate calibration set and close the AccuSlide™ clamp, then insert the spike into the solution container.

b. Open AccuSlide clamp and prime set. Pay particular attention to ensure that all air is expelled from the set. Close the AccuSlide clamp.

c. Connect the output of the set to one side of the three-way stopcock.

d. Load the set.

e. Verify that there is no fluid flow or drops falling in the drip chamber.

f. Plug the instrument into a properly grounded AC outlet.

g. Set stopcock to output to a Class A or B burette.

h. Press channel's POWER switch to turn channel on.

i. Set the primary infusion rate to 400 ml/hr. Set the VTBI to 20 ml.

j. Press the channel's RUN/HOLD to start the primary infusion. Run infusion for one minute, or until tubing and burette are fully primed.

k. Press the channel's RUN/HOLD to stop infusion.

l. Adjust the height of the instrument and/or fluid container as necessary to attain head height of 30" between the middle of the pump mechanism and the fluid level in the container (bag or vented bottle with unvented administration set) or the drip chamber (unvented bottle with vented administration set).

NOTE: You may need to run instrument to prime line to "0" level of burette.

m. Adjust the fluid level so the meniscus is level with the zero mark on the burette.

n. Verify primary infusion rate is 400 ml/hr. Reset the VTBI to 40 ml.

o. Press the channel's RUN/HOLD to start the primary infusion.

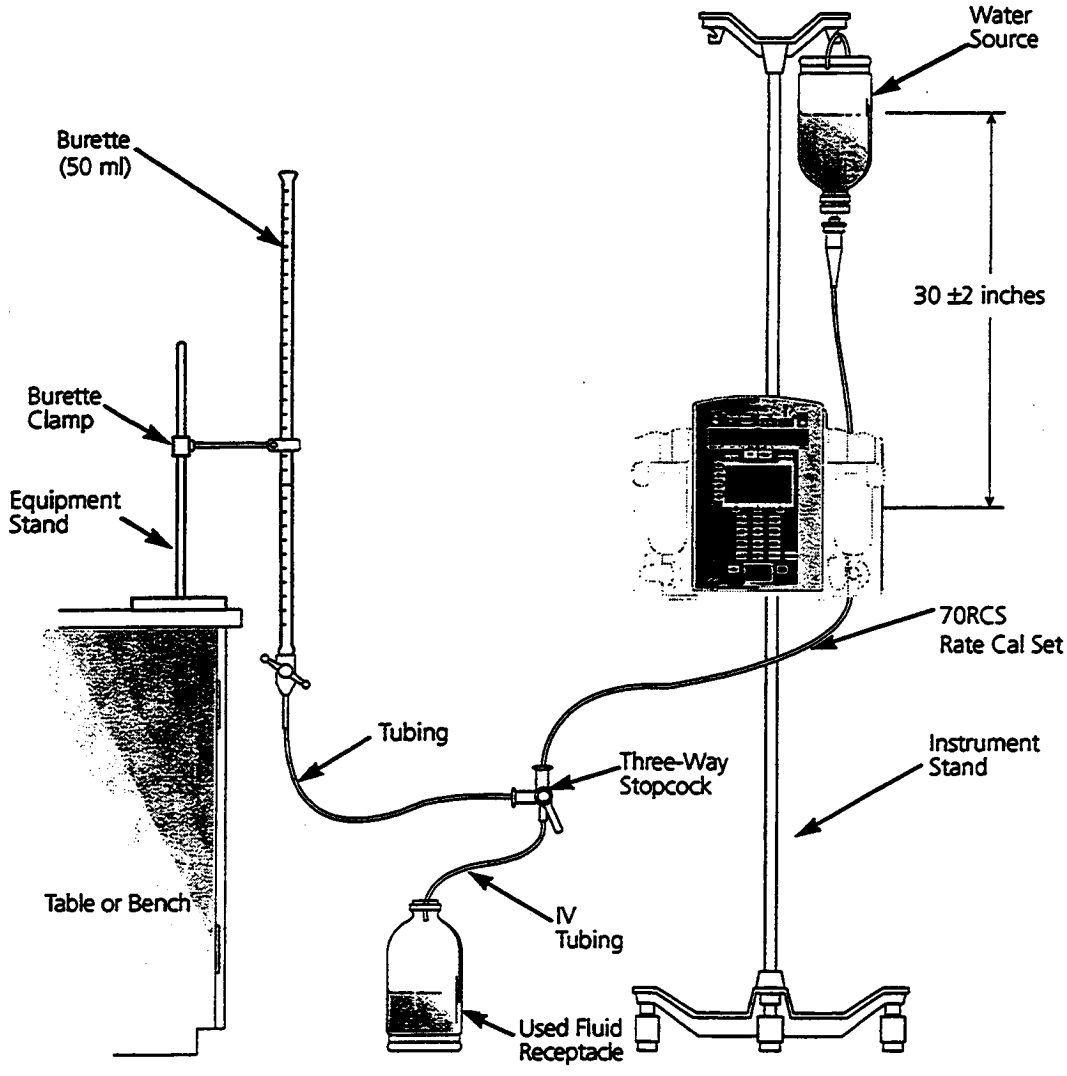
p. The pump will run approximately 360 seconds to deliver 40 ml, then go into KVO mode. Stop the pump within 1 second of KVO operation.

q. Verify the volume collected is 40.0 ml ± 2.0 ml (5%).

r. If rate accuracy verification fails:

1. Ensure 70RCS Rate Cal Set has not been used for more than 40 runs. Refer to Chapter 5 for rate calibration procedure or call ALARIS Medical SystemsTechnical Support.
2. Set stopcock to drain into receptacle.

Figure 3-2 Setup for Rate Verification Test



3.3.5 Pressure Calibration

a. Place instrument on bench or other flat surface and connect to AC power.

b. Connect pressure meter, hand pump, and reservoir to pressure calibration set. Refer to Figure 3-3 "Pressure Test Setup".

c. Install a pressure cal set (70ISS) into the instrument.

d. Enter Diagnostics Mode by pressing and holding top soft key, then turn instrument on and release soft key when diagnostics display appears. Refer to Section 6.4.1 "Entering Diagnostics Mode".

e. Advance to D6 screen by pressing page soft key five times.

f. Select Cal Pressure (A or B for dual channel).

g. Allow 1 hour warmup.

h. Perform soft pressure calibration:

1. With no pressure applied, press the **0 mmHg** soft key.
2. Apply 500 mmHg (±1 mmHg) of pressure.
3. Press the **500 mmHg** soft key.
4. Remove set and pressure from pump.

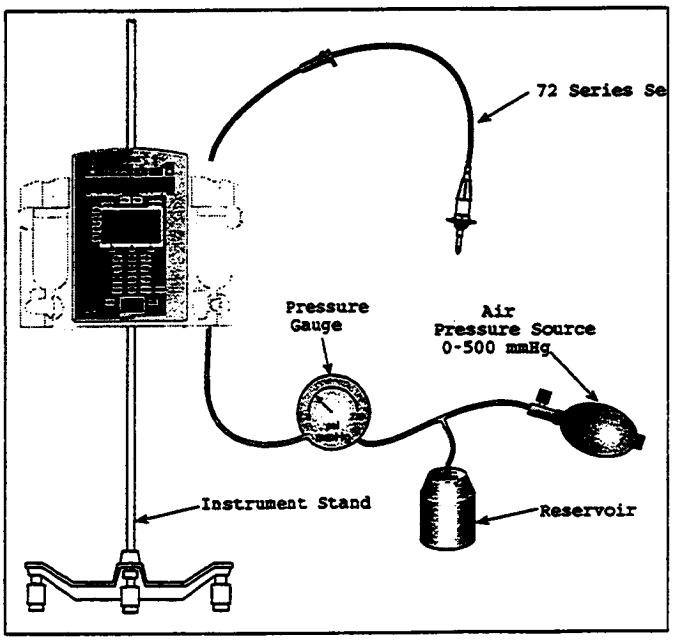
j. Set sensor check/calibration verification:

- Verify both 0 mmHg and 500 mmHg readings say "pass".
- Install set and close latch. Verify reading over 170.
- Verify sensor reading is in the -30 to +80 mmHg range without set installed.. If the pump will not "soft cal," see the hard pressure calibration procedure in Chapter 5.

3.3.6 Ground Current Leakage Test

Use a BIO-TEK®* Model 260 or equivalent to measure the ground leakage current. Refer to the electrical safety tester's operation manual for the proper measurement technique. Leakage current must be ≤ 100 µA for normal and reversed line polarity.

Figure 3-3 Pressure Test Setup



3.3.7 Ground Resistance Test

Use a BIO-TEK Model 260 (or equivalent ground resistance testing equipment) to measure resistance from the the AC power plug ground pin to the screw for the power cord strap or the screw for the battery cover on the chassis. Refer to the test equipment operation manuals for proper setup and measurement technique. The resistance measured must be ≤ 0.10Ω. For Models 7101/7201, measure resistance from AC power plug ground pin to PEC connector must be ≤ 0.10Ω.

CAUTION: Do not connect ground resistance probe to pressure transducer.

3.3.8 Battery Refresh Cycle

a. Initiate a battery refresh cycle by:

1. Disconnecting the battery, pressing ON/OFF switch for 5 seconds and reconnect battery.
2. If software is 2.02 or higher, enter 0.0 AH in the rated capacity for battery (in Diagnostics Mode). Once "ok" is pressed, cycle will start. Set rated cap back to 1.3 AH.

b. Leave connected to AC for 24 hours to complete cycle.

3.3.9 Reset Time

a. Enter Diagnostic Mode and advance to D2 page.

b. Reset hours and minutes as needed from time reference. (See Setting Time in Diagnostics section)

NOTE: Clock will lose about 3 minutes per month since it is not a true real time clock. Once reset, the previous loop will not be affectted or adjusted.

3.3.10 Reset PM Due

Enter Diagnostic Mode and go to D2 page. Access PM Setup and reset PM Due by pressing lower left soft key.

* BIO-TEK® Instruments, Inc.

Table 3-1. PM Inspections

I.D Number_____ Instrument Serial Number_____

	Ref. Section	Frequency	Date Completed	Date Completed
Regular Inspection *(record every 12 months)*	3.3.1	Every Use		
Functional Test	3.3.2	12 Months		
Flow Stop Test	3.3.3	12 Months		
Rate Accuracy Verification Test	3.3.4	12 Months		
Pressure Calibration	3.3.5	12 Months		
Ground Current Leakage Test	3.3.6	12 Months		
Ground Resistance Test	3.3.7	12 Months		
Battery Refresh Cycle	3.3.8	12 Months		
Reset Time	3.3.9	12 Months		

I.D Number_____ Instrument Serial Number_____

	Ref. Section	Frequency	Date Completed	Date Completed
Regular Inspection *(record every 12 months)*	3.3.1	Every Use		
Functional Test	3.3.2	12 Months		
Flow Stop Test	3.3.3	12 Months		
Rate Accuracy Verification Test	3.3.4	12 Months		
Pressure Calibration	3.3.5	12 Months		
Ground Current Leakage Test	3.3.6	12 Months		
Ground Resistance Test	3.3.7	12 Months		
Battery Refresh Cycle	3.3.8	12 Months		
Reset Time	3.3.9	12 Months		

I.D Number_____ Instrument Serial Number_____

	Ref. Section	Frequency	Date Completed	Date Completed
Regular Inspection *(record every 12 months)*	3.3.1	Every Use		
Functional Test	3.3.2	12 Months		
Flow Stop Test	3.3.3	12 Months		
Rate Accuracy Verification Test	3.3.4	12 Months		
Pressure Calibration	3.3.5	12 Months		
Ground Current Leakage Test	3.3.6	12 Months		
Ground Resistance Test	3.3.7	12 Months		
Battery Refresh Cycle	3.3.8	12 Months		
Reset Time	3.3.9	12 Months		

Chapter 4 — FUNCTIONAL DESCRIPTION

4.1 Introduction

This chapter describes the mechanical and electrical systems that comprise the instrument.

The Main PCB for both the single and dual channel instrument is a double sided multi-layered Surface Mount Technology (SMT) board. If a board is determined to have failed, it can be replaced or the unit can be returned to ALARIS Medical Systems for repair. ALARIS Medical Systems does not provide replacement components for repair of SMT boards nor does ALARIS Medical Systems recommend attempting field service of the instrument's SMT circuit boards.

Full Schematics are not included with this service manual.

NOTE: The main PCB board can only be replaced in pumps with main software Rev. 2.02 or higher.

The AC Off Line Switcher and RS-232 boards are replaced as an assembly. If a board is determined to have failed, it is replaced with a new board (see Chapter 7 for part numbers). ALARIS Medical Systems does not provide replacement components for repair of these boards.

Both single and dual channel pumps function in the same manner. However, they use two different Main PCBs. Therefore, the component reference designations are different for each board. To help distinguish between the one and two channel pump reference designations in this chapter, the two channel pump will be represented in parenthesis and italicized; e.g., (*U13*).

4.2 Principle of Operation

The pump contains a peristaltic pumping mechanism and support circuitry to ensure controlled flow. The peristaltic mechanism consists of a linear array of 12 cam followers which travel perpendicular to the administration set. These cam followers act like "fingers" kneading the membrane. When the fluid-filled disposable is placed against the array of cam followers, the coordinated, sinusoidal motion of the cams causes a peristaltic wave of fluid displacement in the pumping segment of the disposable.

The pump will alarm at signs of internal problems and at preset thresholds for external problems (for example, when battery charge falls below a critical level, or pump output pressure exceeds a programmed limit). All alarms provide visual and auditory signals to alert the operator.

Accuracy of fluid delivery is a function of the microprocessor-controlled rotation cycle of the camshaft, and the administration set section compressed by the cam followers.

4.3 Overview

The instrument contains one Main PCB and several modules that interface to it. The interfacing modules are as follows:

- LED module
- Graphic LCD module (MAIN)
- Lower LCD module
- Battery
- AC Off Line Switcher
- Keypad
- Nurse Call/RS-232 board
- Motor
- Air-in-line sensors
- Pressure module
- Motor rotation sensor and the mechanism latch detector (optocouplers).
- ECD board

The instrument power is supplied through the AC Off Line Switcher module and the battery.

The Main PCB contains all the control circuitry required for the instrument. The board can be broken down into four main sections; kernel, power system, motor drive and sensor control, and user interface circuitry.

a. The microprocessor, RAM, ROM, data communication, and COMBO IC make up the heart of the system. These are collectively referred to as the kernel. The kernel is responsible for controlling the motor actuation, sensing and responding to user input, monitoring various system sensors, and performing start-up and on-going system operational testing.

b. The power system is responsible for charging the battery, generating the DC power supplies, notifying the user of the number of hours of battery life remaining on the battery and performing watchdog (clock sync checks) functions. The power system includes the Battery Manager custom IC.

c. The motor drive and sensor control circuitry drives the motors, the air-in-line sensors, the mechanism latch detectors, and the rotation detectors. The circuit is also responsible for monitoring the pressure sensors, the power supply voltages, the motor current, and the air-in-line sensor outputs.

d. The user interface circuitry connects to the key-pad, LED modules, and LCD modules to the kernel circuitry for monitoring and control. This circuitry also contains the audio interface, and audio test.

Figure 4-1 Main Block Diagram

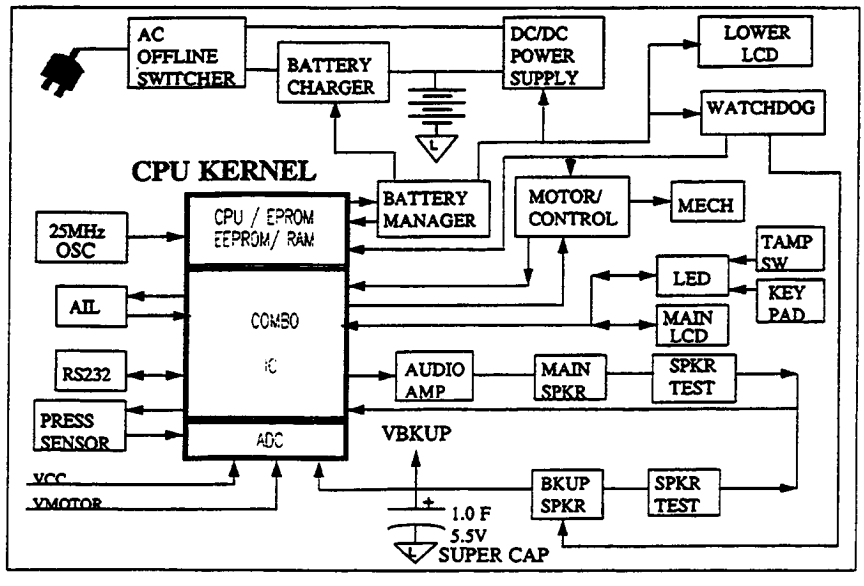


Table 4-1. Definition of Terms

80C188	Microprocessor that controls all instrument operations.
A/D (A2D)	Analog to digital converter.
Battery Temperature Sensor	Monitors the temperature inside battery to ensure optimum battery capacity.
Battery Assembly	Contains battery, battery temperature sensor, and thermal cutout.
Channel A	Refers to left mechanism, sensors, and LED module.
Channel B	Refers to the right mechanism, sensors, and LED module.
COMBO IC	A custom integrated circuit with many I/O functions.
DIP	Dual Inline Package. A form of electronic part packaging which mounts on pins extending through a printed circuit board.
EEPROM	Electrically Erasable Programmable Read Only Memory. Memory whose data can change under CPU control. Data is not lost if power is removed.
EMI	Electromagnetic Interference.
EMC	Electromagnetic Compatibility. The ability of the instrument to operate in the presence of other electrical devices.
EPROM	Erasable Programmable Read Only Memory. Memory whose data is fixed and does not change. Data is not lost if power is removed.
ESD	Electrostatic Discharge.
Kernel	Circuit consisting of CPU, program memory (EPROM), data memory (RAM), associated I/O, and time bases.
Keypad	Membrane switch panel.
LCD Module	Liquid crystal display (LCD) for alpha-numeric display (128 x 64) of prompts, status, and setup information.
LED Module	A custom light emitting diode (LED) module that contains numeric LED's, annunciator blocks, status indicators, and a custom integrated circuit.
Mechanism Latch Detector	Optical switch to detect the status of the latch on the mechanism.
Motor Rotation Detector	Optical switch used with a decoder disk.
PLCC	Plastic Leaded Chip Carrier. A form of electronic part packaging which mounts on the surface of a printed circuit board.
Battery Manager	Custom programmed microcontroller, used for battery management, control of the Lower LCD Display, power on and watchdog functions.
PQFP	Plastic Quad Flat Package. A surface mountable electronic package.
RAM	Random Access Memory. Memory whose data can change under CPU control. Data is lost if power is removed.
System Watchdog	A circuit which monitors the proper operation of the 80C188 microprocessor and clocks.
UART	Universal Asynchronous Receiver Transmitter. A logic device which formats data as a serial bit stream for remote communications.
Ultrasonic AIL Transducer	A sensor used to detect air in the tubing. Passes high frequency sound through fluid filled set.
VCO	Voltage controlled oscillator. An oscillator where output frequency can be varied through a control voltage.

4.4 Main PCB

4.4.1 Processor Kernel

The processor kernel is responsible for controlling the motor actuation, sensing and responding to user input, monitoring various system sensors, and performing start-up and on-going system operational testing. The kernel is based on a 16 bit 80C188 microprocessor U11 (*U15*), 512K Bytes of EPROM program storage, and 64K Bytes of battery backed up RAM data storage. In addition, the kernel has 2K bits of EEPROM memory and a 9600 baud serial communications interface.

The COMBO IC U10 (*U14*) is a custom ASIC (Application Specific Integrated Circuit) which incorporates timing, address decoding, digital I/O, and other system "glue" functions. The Combo IC has a 16 bit CRC generator which is used to periodically test the EPROM data. The COMBO IC also contains the local serial interface control logic used to interface to serially accessed peripherals such as the A/D, EEPROM, LED Module(s), and Battery Manager. Additional information can be found in Section 4.4.2 "COMBO IC".

The kernel data communications function supports RS-232 level serial communications up to 9600 baud. The UART function is embedded in the COMBO IC, while the RS-232 interface is based on an industry standard RS-232 level converter chip. The communications channel is EMI filtered and ESD protected to 10 kV with components on the RS-232/Nurse Call board and is not electrically isolated. The interface supports two signals (TxD and RxD) along with ground.

4.4.2 COMBO IC

The COMBO IC, U10 (*U14*), is a 160 pin PQFP device which supports a variety of kernel functions, primary audio support, digital I/O and other functions. The COMBO latches the address bus and outputs the latched addresses as A19-A16, and A7-A0. The COMBO IC has a 16 bit CRC generator which is used to periodically test the EPROM data. The RAMTEST circuit provides redundant storage and error detection of RAM data. The local serial interface control logic is used to interface with serial accessed peripherals such as the A/D converter, EEPROM, LED Module(s), and Battery Manager. The device also generates the Main LCD interface control signals. The UART (Intel 8251 equivalent) and three 16 bit counters (Intel 8254 equivalent) are also provided inside the COMBO chip. Six pulse width modulators for motor control and LCD backlight and contrast are also within the custom IC.

4.4.3 EEPROM

The EEPROM is used to store all configuration and diagnostic settings. The EEPROM, U9 (*U11*) is accessed using the serial control unit within the COMBO IC. Data is written and read back from the device through the serial data registers within the COMBO chip.

This device holds 128, sixteen bit words. It is used to store data that will not be destroyed if power is lost to the instrument. The EEPROM will store configuration mode, calibration (LCD contrast) settings, and certain diagnostic information e.g., instrument ID number, PM interval, PM on/off, battery run time, and total instrument run time.

NOTE: The event log is not stored in the EEPROM.

4.4.4 RAM

The RAM is used to store user set parameters, e.g., Volume To Be Infused (VTBI), mode, rate, and PRI/SEC, as well as the event log. The instrument provides read/write memory integrity by using redundant storage and automatic comparison. Data written to RAM is stored in both of the RAM devices, main RAM, U8 (*U9*) and phantom RAM, U4 (*U5*). The processor reads data directly from the main RAM. The phantom RAM data only goes to the COMBO IC. The COMBO IC compares the data from the two RAMs on each read. If the data does not match, a bit will be set in a register within the COMBO IC.

When the pump is off the VRAM supply is still on,

preserving the contents of the RAMs. The second chip select line, CS2, of the RAMs is tied to RST_CPU*, so that the RAMs can not be selected during power down sequence.

4.4.5 EPROM

The EPROM (CMOS), U3 (*U4*), contains 512K bytes (x8) of program memory. The EPROM is held in a socket. To change the EPROM the instrument must be opened. Turn the instrument off and disconnect from AC power before opening the case to replace the EPROM.

4.4.6 RS-232 Interface *(7100/7200 only)*

The RS-232 serial communications is supported by a UART (Universal Asynchronous Receiver/Transmitter) which is located inside the COMBO IC. The UART is equivalent to an Intel 8251. The UART's outputs drive interface U22 (*U45*), which converts the logic level signals to RS232 levels. The system can support up to 9600 baud rate.

4.4.7 RS-232 Interface *(7101/7201 only)*

The isolated RS-232 Interface provides 500VAC electrical isolation between the RS-232 signals on the RS-232 connector and the rest of the instrument as well as connections for the speaker, tamper switch, and flow sensor interface option. The isolation is created using optical isolators U3 and U4 for the signals and an isolation power transformer T1 for isolated circuit power. Voltage level conversions are generated by the MAX250/25 1 chip set U1 and U2 to generate the appropriate signal conditioning. Limit resistor R1 converts the RS-232 signal levels, nominally ±6V, to match the input signal range required by U1.

NOTE: The RS-232 board in the International version is isolated and hence cannot have trhe Nurse Call option.

Figure 4-2-a COMBO IC Block Diagram

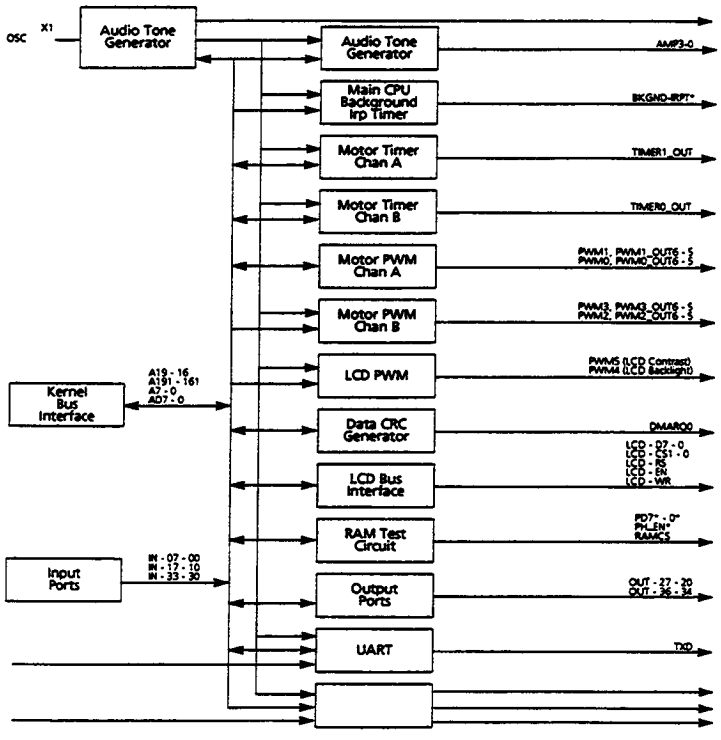


Figure 4-2-b COMBO IC Block Diagram

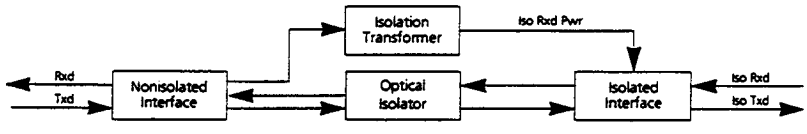
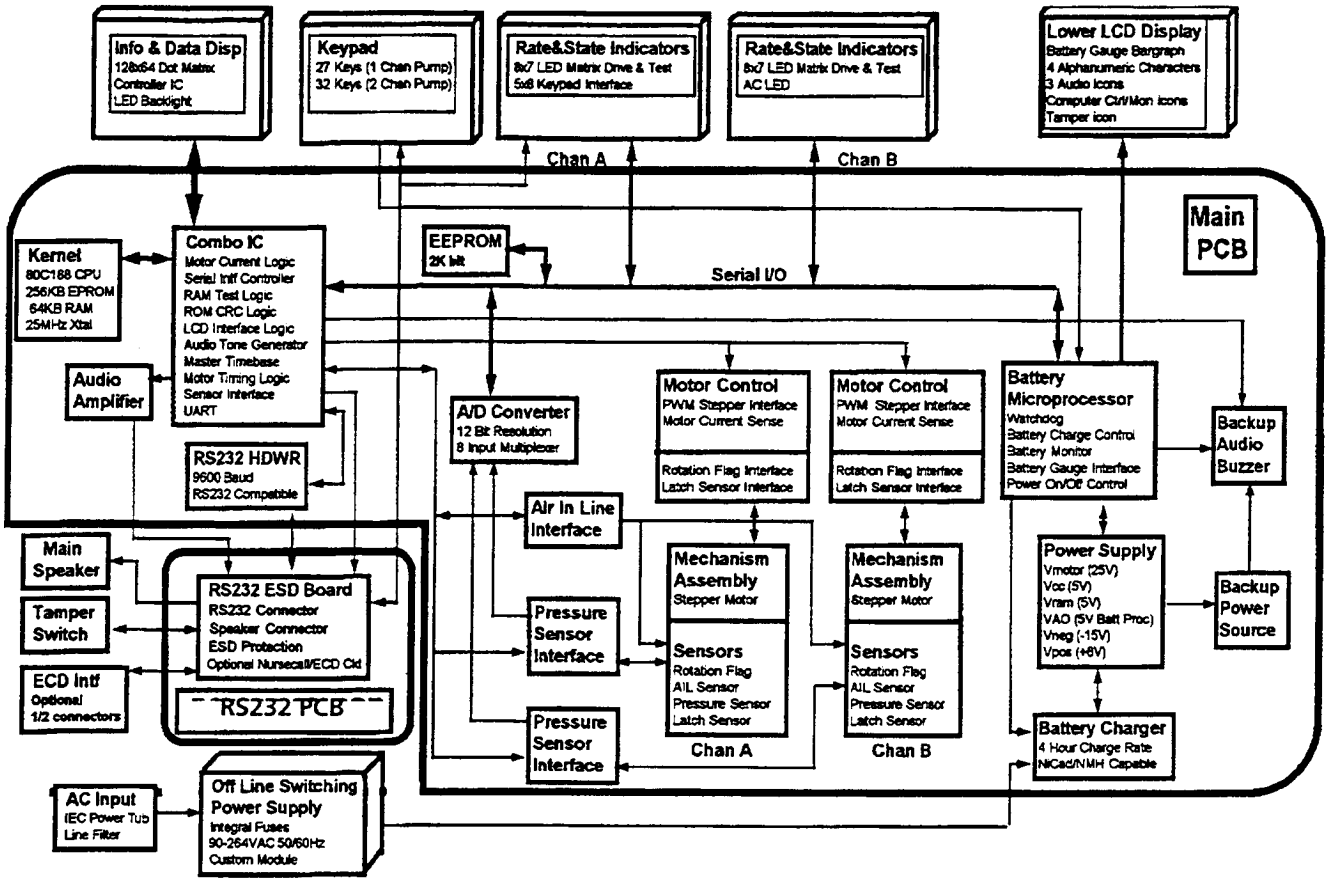


Figure 4-3 Electrical Partitioning



4.5 Power System

4.5.1 Battery Manager

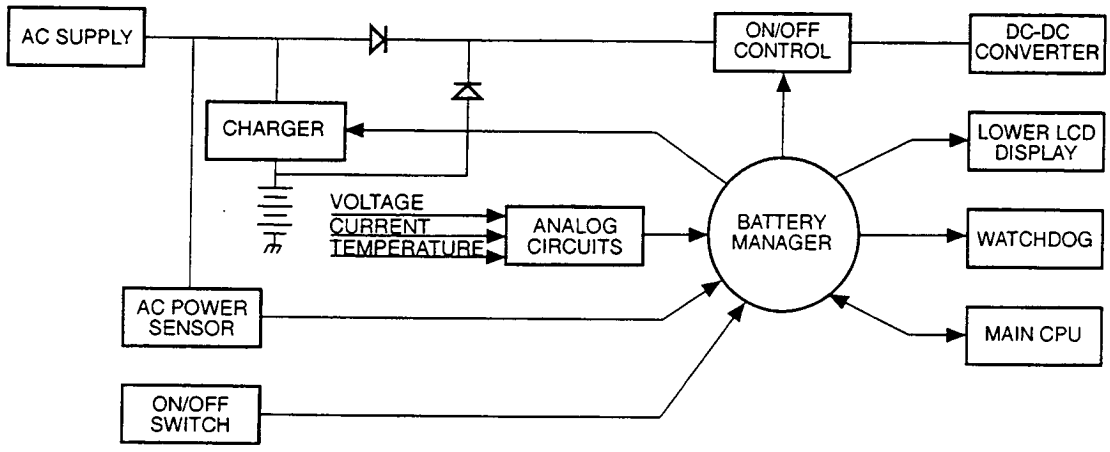
For general information, also refer to Chapter 1.

The Battery Manager, U34 (*U40*), is a custom programmed microcontroller with 4K of ROM and 1K of RAM memory. The Battery Manager has two system time bases, a 32 kHz crystal, Y2, and a 4 MHz ceramic resonator, RESN1. In normal operation the Battery Manager operates at 4 MHz. Under low power condition (instrument is off and AC is unplugged) the Battery Manager switches to the lower frequency to save power. The battery manager is turned on for three seconds every minute when the pump is off and connected to AC power.

The Battery Manager has the following functions:

- Instrument on/off
- Battery charge control
- Battery gauge
- Battery warning and alarm
- Relative time clock
- Displays configuration name
- Instrument icon display
- Inter-processor communications
- Processor self test
- Error detection (battery, temperature input, current integrator, power on/off, and watchdog faults)
- In-circuit test.

Figure 4-4 Battery Manager Block Diagram



4.5.2 AC Off Line Switcher

NOTE: Refer to Figure 4-5 "Battery Monitor" and Figure 4-6 "Main Power Supply" when following Sections 4.5.2 through 4.5.17.

The AC Off Line Switcher is an AC to DC power converter capable of running the instrument and supplying 22-24V @ 1.5A to the battery charging circuit from an input of 85-264VAC 50/60 Hz. The module has foldback current limiting to protect against output shorts. It contains two input fuses which are designed for worst case hospital line transients and they will only blow if there is a fault in the module. There are no user adjustments in the module.

4.5.3 Battery Charge Regulator

The battery charger circuit is a step-down (buck type) switching regulator, U20 (*U28*), configured to provide a constant current of 1A through the battery whenever the charge control signal, CHARGE*, is low. The input to the battery charger regulator is DC_INPUT, which is generated by the off line switcher between 22-24V.

The circuit measures the battery charge current through a 0.1 ohm resistor, R29 (*R43*), between the battery and "P" ground. This voltage is amplified and sent to the feedback input of the switching regulator U20 (*U28*). The regulator will keep the voltage at the feedback pin at 1.23V by adjusting its output pulse width. The gain of the amplifier is set so that an average current of 1A through the 0.1 ohm sense resistor will result in the 1.23V feedback voltage.

The Battery Manager controls the average current into the battery by varying the duty cycle of the charge control. There are four possible phases for the average current charge cycle.

a. Fast charge phase charges at 1 amp within limits on the ambient temperature. The Battery Manager charges with this phase until one of the following charge criteria are met.
   - Battery voltage drops at least 192mV below the peak value.
   - Battery temperature is more than 7°C above starting temperature and at least 30°C.
   - Total charge time exceeds 3.2 hours.

b. Top-up charge phase starts after fast charge if the battery temperature is less than 37°C, at an average of 180mA for 180 minutes. This average current is produced by charging at 1 Ampere for 0.9 seconds every 5 seconds.

NOTE: The charger will turn off if the battery gets too hot (>37° C) to let the battery cool down. Cool down time is not included in the 180 minute charge time.

c. Float charge phase charges at an average current of 40mA in a fully charged battery. This average current is produced by charging at 1A for 0.2 second every 5 seconds.

d. Hot charge phase charges at a rate of 180 mA for a total time of 18 hours if battery temperature is more than 36°C. Charge stops above 43° C and starts below 43° C, the cool down time is in addition to the 18 hour charge time.

Table 4-2 Battery Trip Points

Battery Voltage	Instrument Response
12.0V (Single) 12.1V (Dual)	• 15 minutes left on gauge • Unit continues to function • Warning tone activated • Low battery warning
11.45V	• Unit does not pump • Constant alarm • Low battery alarm (Depletion)
10.25V	• 5 min after low batt alarm • Backup speaker activated • Instrument shutdown (5 min. after alarm)
9.75V	• No AC power applied • Battery disconnected from circuit by shutdown signal.

4.5.4 Refresh Cycle Load

The battery refresh feature uses the refresh cycle load circuit to add an additional resistive load across the battery to accelerate the discharge when the instrument is plugged into AC and the instrument is either on or off.

The signal DUMP_RES, generated by the Battery Manager, is used to turn on the FET transistor, Q9 (*Q34*), to apply the 47 ohm, 7 Watt, R273 (*R353*) load to the battery.

4.5.5 VAO Shutdown

VAO_SOURCE is used to supply power to the Battery Manager, its supporting circuitry and the RAMs. When the instrument is turned off, these supplies remain active. If AC is unplugged, and the battery has decreased to approximately 9.75V, the Battery Manager has the ability to remove these supplies from the battery load. This circuit is designed to protect the battery by preventing the battery from getting fully discharged. The Battery Manager generates the signal SHUT_DOWN* to remove the VAO_SOURCE from the battery load. When the SHUT_DOWN* command has been given the Battery Manager will lose power as well as the RAMs and Lower LCD display. This power will only be restored when AC power is connected.

NOTE: The instrument's operation, after the battery is disconnected, is the same as the Battery Manager generating the SHUT—DOWN signal and requires the instrument to be plugged into AC after the battery has been reconnected.*

When the SHUT_DOWN* signal is asserted low, Q37 (*Q39*) will turn off, which opens the path from the battery to VAO_SOURCE.

4.5.6 AC Line Sense

The AC power sense circuit detects the presence of AC power and notifies the user and the Battery Manager of its status. The DC_INPUT is the output of the AC Off Line Switcher and should be between 22 to 24V. When the input voltage, DC_INPUT, reaches at least 15V, the circuit will recognize that AC has been plugged in. When AC power is detected, the AC LED on the LED module is lit and a status input to the Battery Manager, AC_PWR, is asserted high. The circuit is designed to switch off the LED quickly when AC power is removed.

When DC_INPUT is at least 15V, the voltage through the sense circuit is high enough to turn on the AC led within the LED module. The AC_LED signal will be about 1.5 to 2.4V when the LED is on.

4.5.7 System Power Source Select

The system power source, DC_DC_SOURCE, is used to drive three switching power supplies. It is controlled by the Battery Manager through the signal PWR_ON. When the instrument is on, the DC_DC_SOURCE is normally supplied by either the battery or the AC off line switcher if the instrument

is plugged into AC. The Battery Manager disconnects the AC source during the battery refresh cycle.

When the Battery Manager asserts PWR_ON high, Q24 (*Q41*) will turn on. If PWR_AC is high, Q7 (*Q25*) will turn on, and DC_DC_SOURCE will be supplied by the DC_INPUT.

If PWR_AC is high, Q8 (*Q21*) is on and DC_DC_SOURCE will be supplied by the battery.

4.5.8 Battery Voltage Monitor

The battery voltage can range from 10 to 18V. The Battery Manager monitors the battery voltage through its internal A/D converter. The valid input range of the A/D converter is 0 to 4.1V. The battery voltage must be reduced to meet the input requirements. The 4.1V reference and the voltage subtracter-multiplier amplifier circuit U29-5 (*U37-5*) scale the battery voltage and maintain an accuracy of ±15 counts (1 count = 1mV).

The Battery Manager uses the battery voltage for its charging, battery gauge, error detection, and battery alarm and warning features.

When MEASURE is low Q27 (*Q43*) will open and remove BATT_PLUS from input to U29 (*U37*). Also MEASURE being low will open Q26 (*Q45*) so that VMEAS is removed as well.

4.5.9 VMEAS

VMEAS is the supply used to power the REF 4.1V reference circuit, the voltage monitor circuit, and the current monitor circuit. The Battery Manager turns VMEAS off by setting the MEASURE signal low when the instrument is off and AC is unplugged to reduce the load on the battery. In this condition, the Battery Manager turns VMEAS on once a minute to check the battery's voltage and temperature.

The 12V Zener CR31 (*CR41*) is placed between the gate and source of the FET, Q26 (*Q45*), to limit the gate to source voltage. The FET can see up to 24V but the Vgs (Voltage gate to source) of the FET is only rated to 20V.

4.5.10 Voltage Reference 4.1V

The 4.1V reference is used in the voltage monitor circuit, the battery temperature sensor circuit, the ambient temperature sensor circuit, and is the reference voltage for the A/D converter in the Battery Manager. The reference voltage is 4.096V ±2%. VMEAS, which can be between 7.7 to 24V, turns on the precision reference Zener U27 (*U47*).

4.5.11 System Current Monitor

The circuit to measure the supply current uses a 0.1 ohm resistor, R32 (*R86*), to generate a voltage drop. The resistor is placed between "P" ground, the ground from the AC Off Line Switcher, and "L" ground, the ground to the rest of the instrument (The battery charger circuit is tied to "P" ground so that the battery charge current is not measured as system load current). The amplifier, U29-7, (*U37-7*) is designed as an integrator. Since the "P" ground voltage will be less than the "L" ground voltage a current will be generated in a resistor tied to the operational amp's negative input, to maintain equal voltage levels at the operational amp inputs. This current charges the feedback capacitor, C52 (*C56*), thereby integrating the current as long as the feedback transistor, Q30 (*Q48*) is off.

The Battery Manager integrates the current for 100 ms, 1 ms before resetting the integrator by pulsing the signal RESET_I high for 1 ms. Forcing RESET_I high will turn on Q30 (*Q48*) thereby placing a short across the feedback capacitor, C52 (*C56*). The resulting output voltage, I_MON, is fed to an A/D input of the Battery Manager. At a 1A load current the output voltage is about 2.7V. The Battery Manager samples I_MON once before the RESET_I signal is pulsed high and once after. The difference between the two samples becomes the current measurement. The Battery Manager uses the current measured for: charging, to monitor current in and out of battery, battery gauge, updates gauge under present power requirements, and error detection functions.

4.5.12 Always On Supply (+5VAO)

The always on supply, U39 (*U43*), is used to power devices that remain powered when the instrument is off e.g., Battery Manager circuitry and VRAM. The supply is regulated at 5V ±5%.

4.5.13 System Switching Supplies

The system switching supplies provide regulated +5V, +29V, and -15V power to the logic, display, motor, and sensor circuits. Each of the supplies uses an integrated switching regulator IC which provides thermal overload protection, internal oscillator, internal reference, and current limit functionality. The DC_DC_SOURCE voltage is applied to three switching power supplies:

a. The +5V supply U17 (*U31*) is a step down ("buck") configuration switching regulator which provides a lower output voltage (5V ±5%) than input voltage (10V-24V). The supply can provide in excess of 1A peak. Output clamp Zener diodes limit circuit damage in the event of regulation failure. The regulator has an internal pass element which turns on current to the output inductor until the output voltage, as sensed through the sense resistors, reaches the internal 1.23V reference voltage. It then turns off and the inductive flyback voltage created is clamped by a catch diode.

b. The VMOTOR supply U21 (*U26*) is a step up ("boost") supply which provides a higher output voltage (29V ±1.5V) than the input supply (9V-24V). The supply can provide up to 1A peak and has a soft start feature to limit inrush current upon starting. The internal pass element shorts the output side of the power inductor to ground, then releases it, generating about 29V at the cathode of a diode. This voltage is sensed by a resistor pair and the loop controlled to generate a 1.23V reference signal level.

c. The VNEG supply U16 (*U30*) is a buck-boost supply which generates a negative supply (-15V ±1V) from a positive supply (9V-24V). The supply can provide about 100mA. The IC ground pin is bootstrapped to the negative output voltage. Then, referencing the feedback signal to ground potential allows the chip to sense the negative voltage and therefore regulate it. In operation, the internal pass element provides current through the inductor while on. When the pass element turns off, the flyback action of the inductor generates a negative voltage spike which is captured across a capacitor though a steering diode.

4.5.14 VRAM Supply

The VRAM supply is a 4.8V supply generated for the RAMs to keep them active when the instrument is turned off. When the instrument is off, VRAM is sourced by +5VAO through a diode. When the instrument is on, VRAM is sourced by +5V through a diode.

4.5.15 VPOS Supply

A linear regulator, U2 (*U1*), from a DC-DC Source provides a 6V supply for the pressure transducer and A/D circuits. The output voltage is dependent on the voltage gain of the amplifier, approximately 1.5 times the input reference voltage. The power is supplied by the DC_DC_ SOURCE while the reference is ADVREF_RAW. The transistor Q1 (*Q1*) is used as a pass transistor to boost the current supplied by the amplifier.

4.5.16 Battery Temperature Sensor

The battery temperature sense circuit measures the temperature in the battery pack through a nominal 10 kilohm @ 25°C thermistor. The thermistor is the same type as used in the ambient temperature sense circuit. The sensor will measure, with a 2.5°C accuracy, over the temperature range 0° to 65°C. The circuit is a voltage divider between a resistor and the thermistor with a 4.1V reference voltage used as the input voltage. The output BATT_TEMP drives an A/D input to the Battery Manager.

The Battery Manager uses the battery temperature in its error detection and charging functions.

Figure 4-5 Battery Monitor

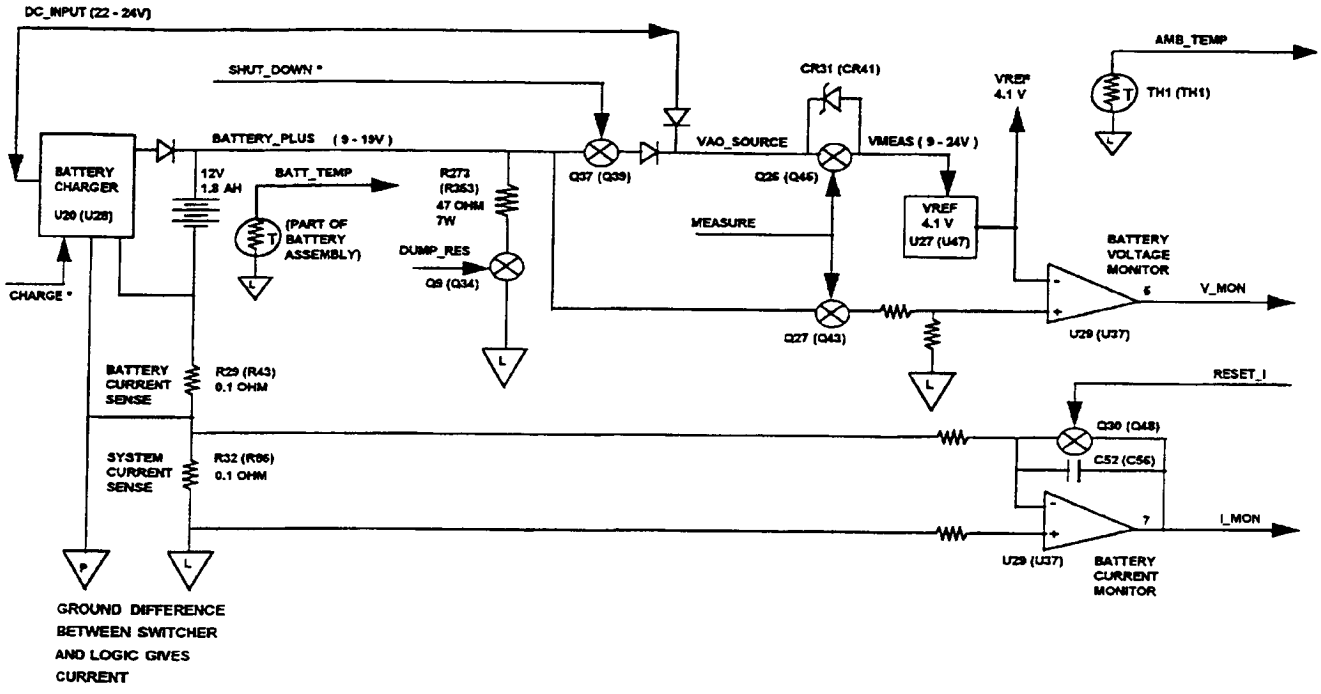
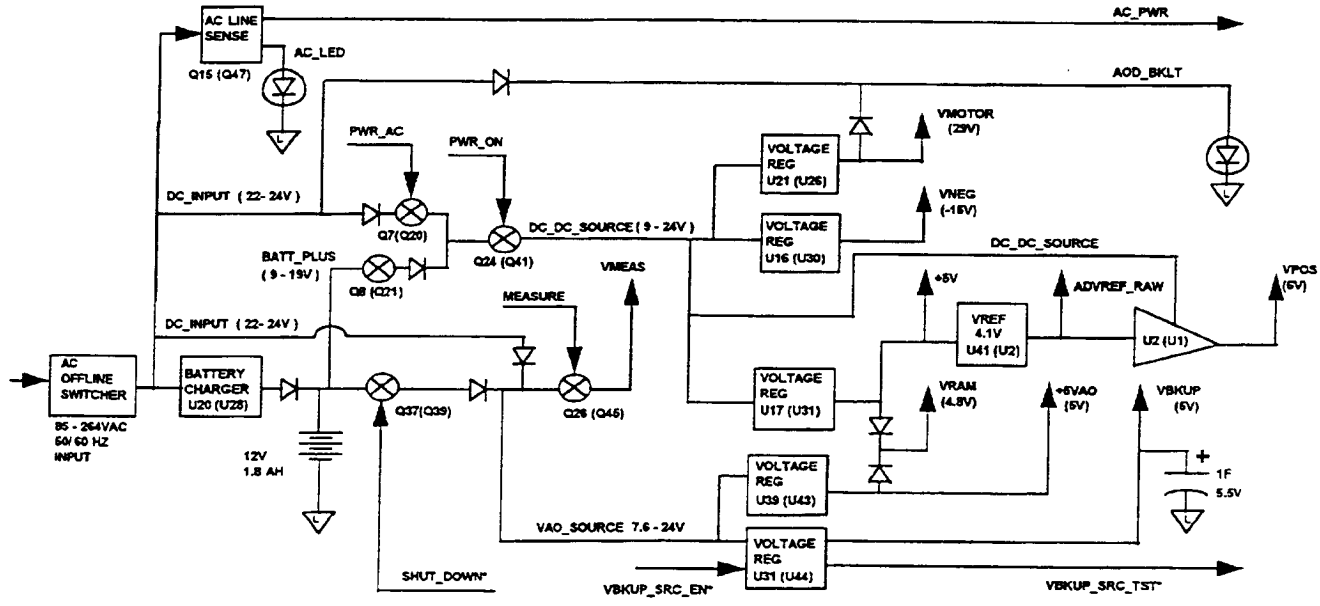


Figure 4-6 Main Power Supply



4.5.17 System Watchdog

The system watchdog provides a monitor on the operation of the main processor and the Battery Manager. It also provides an independent clock signal to the main processor for continuous comparison with the main time base. The Battery Manager controls an output signal (10 Hz) that performs multiple functions.

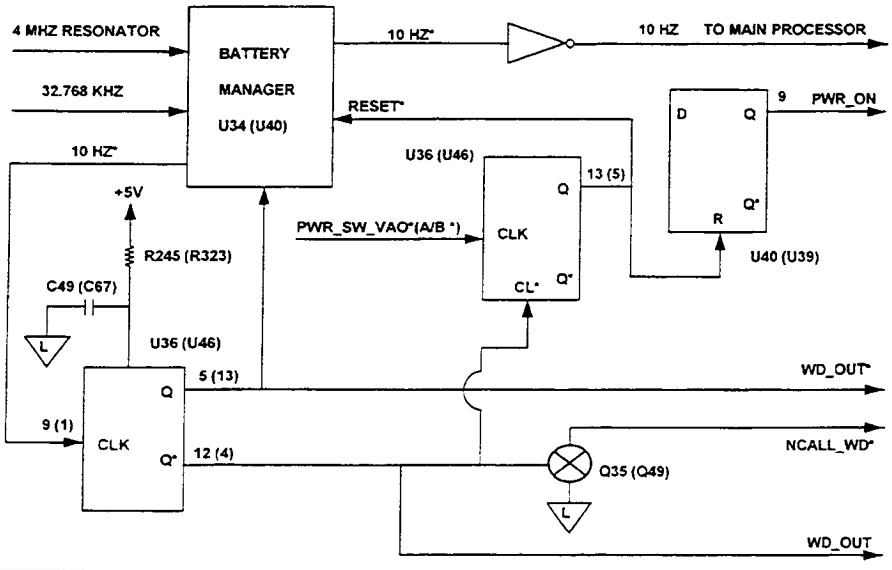
The 10 Hz* has three states; continuous high, continuous low, or oscillating at 10 Hz. 10 Hz* is continuously low when the instrument is off or a watchdog error has been caused by the main processor. 10 Hz* is continuously high whenever the Battery Manager detects an error within the Battery Manager itself. 10 Hz* oscillates at 10 Hz when the instrument is on and no watchdog errors have occurred.

When the 10 Hz signal begins to oscillate the watchdog outputs, WD_OUT, and WD_OUT* will be deactivated. The one shot, U36-9 (*U46-13*), keeps its output Q high as long as the falling edges of the signal (10 Hz*) are faster than the pulse width of the pulse generated by R245 (*R323*) and C49 (*C67*) which is 105 to 220 ms. The Q* output of the one shot, U36-12 (*U46-4*) disables the second one shot U36-13 (*U46-5*). The second one shot is only enabled when the watchdog is in alarm.

When 10 Hz* is not oscillating, the one shot, U36-5 (*U46-13*), will not trigger, therefore, output Q is low and Q* is high. The watchdog outputs, WD_OUT* and WD_OUT, are activated until the Battery Manager releases them, by generating the 10 Hz* output. The NCALL_WD* signal is also brought low because WD_OUT turns on Q35 (*Q49*). Whenever the 10 Hz* stops oscillating and is high, a watchdog error has occurred within the Battery Manager itself. The 10 Hz* signal being high, prevents clock pulses to U36-9 (*U46-1*) and the one shot to time-out so the output Q (WD_OUT*) goes to zero and Q*(WD_OUT) goes to a high. Once WD_OUT is high the second one shot, U36-13 (*U46-5*) is enabled. If the user presses either on/off switch, U29-10 (*U42-10*) output will go high sending a 4 to 11 ms pulse to the Battery Manager reset input. This allows the user to reset the Battery Manager through hardware when the Battery Manager is stuck in a watchdog error. The system power is also turned off at this time because the pulse resets the power latch,U40-9 (*U39-9*) bringing PWR_ON low.

The 10 Hz* signal also goes to an interrupt input of the main processor. It is used to compare the time base of the main processor with the time base of the Battery Manager. Nominally, the timebase is 100 ms ±1 ms from falling edge to falling edge.

Figure 4-7 System Watchdog



4.5.18 Power Switch

The power on/off switch(es) are located on the keypad. The switch(es) are not included in the standard keypad matrix. One (*Two*) output(s) is generated, PWR_SW* (*PWR_SW_A/B**), one for each channel. The signals are pulled up to 5V, by VBKUP supply, through two pull-up resistors. (VBKUP is the supply for the backup audio.) These signals are decoupled from the signals that drive the Battery Manager logic, PWR_SW* (*PWR_SW_A/B**), through two 100K resistors. The PWR_SW* (*PWR_SW_A/B**), signals drive interrupt inputs in the Battery Manager, U34 (*U40*), and are used by the error reset and power on circuits. Upon recognition of the power switch, the Battery Manager controls when the main processor and the rest of the circuit will receive power.

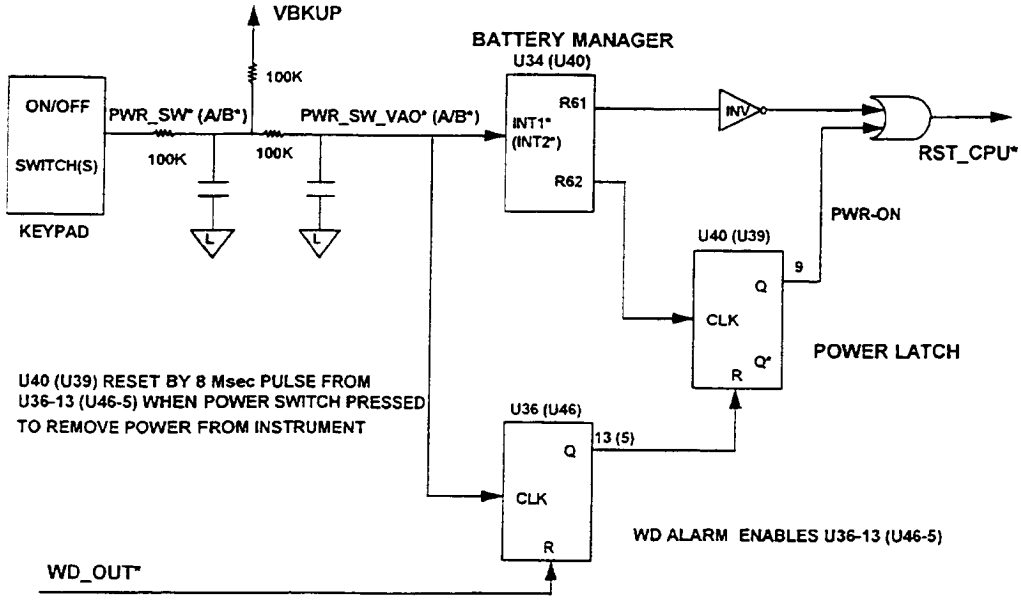
4.5.19 System Reset/Power On

System Reset is controlled by the Battery Manager. Either the lack of a reset inactive signal from the Battery Manager, U34 (*U40*) signal R61 or the lack of the PWR_ON signal being asserted will initiate a RST_CPU*.

Power on is also controlled by the Battery Manager. Under normal conditions the Battery Manager uses its output R62 to toggle the power latch, U40-9 (*U39-9*), to turn the instrument on/off. The Battery Manager turns PWR_ON high when the instrument is on and turns PWR_ON low when the instrument is off.

If the instrument is on and a watchdog error is active, WD_OUT* is asserted low. The second one shot, U36-13 (*U46-5*), will be enabled. When the power switch is pressed an 8 ms pulse is generated at the Q output of U36-13 (*U46-5*). The pulse resets the power latch, U40-9 (*U39-9*), System Reset is controlled by the Battery Manager. Either the lack of a reset inactive signal from the Battery Manager, U34 (*U40*) signal R61 or the lack of the PWR_ON signal being asserted will initiate a RST_CPU*.

Figure 4-8 System Reset/Power On



4.5.20 Lower LCD Display Backlight Drive

The backlight for the Lower LCD display contains 6 LEDs in series. The signal AOD_BKLT is tied to the anode of the first LED in the series. Each led has about a 2V forward drop. So AOD_BKLT will be about 12-13V when the LEDs are turned on.

The Lower LCD display backlight drive circuit controls the amount of current supplied to the LEDs. The circuit contains two current sources "or'd" together. One current source is powered from DC_INPUT, the voltage supply from the AC off line switcher. The second source is powered from VMOTOR which is generated when the instrument is on.

The circuit has four modes of operation:

a. First, if the instrument is off and unplugged, the backlight driver is off. The two power supplies that drive the circuit are both off.

b. In the second mode, the instrument is off but plugged into AC. The current to the LEDs is limited by a resistor under these conditions. VMOTOR will not be on, therefore only the DC_INPUT path will generate the current for the LEDs. The current in the LEDs will be about 4 mA.

c. Under the third situation, the instrument is on and plugged into AC. Now both current sources are on, driving the LEDs for maximum brightness. The current to the LEDs should be around 6 mA.

d. And lastly, the instrument is on and not plugged into AC. Now only VMOTOR is on, so the driver generates the current to turn on the LED. The current should be around 2 mA.

4.6 Motor Drive/Sensors

4.6.1 Motor Drive

The stepper motor drive circuit consists of a dual H bridge to provide voltage to each winding of the hybrid stepper motor, and a voltage comparator to control the duration that voltage is applied to each motor winding.

The sequence of operation for a single phase [Phase 1 (*A*)] of the motor is as follows:

a. Phase A, MTR_PH_1 (*MTRA_PH_1*) is active, which causes the high side switch and low side switch (diagonally opposite the high side switch), to close. This presents the motor supply voltage across the motor winding. The signals MTR_1A (*MTRA_IA*) and MTR_1B (*MTRA_1B*) are used to drive the motor.

b. Current will begin to increase at a rate determined by the ratio of the motor voltage to the inductance of the motor; e.g., about 0.5 amps/millisecond, and flow in the direction indicated by the arrow shown. The current will increase in the sense resistor at the same rate and result in a voltage sensed by the comparator.

c. Once the sense resistor voltage MTR_I1 (*MTR A/B_I_1*) rises above the reference voltage at the comparator inputs, U14 (*U27*), the comparator output, U14-1 (*U27-7*) will switch low forcing the high side switch to open. The low side switch will always remain closed until a phase change occurs. With the supply voltage now removed from the coil, the coil current and the sense resistor current will decay. Once the sense resistor voltage drops below the reference voltage, the comparator will turn the high side switch back on. The comparator circuit has been designed with a fixed turn on delay of 50 microseconds. This is a result of the RC network on the output of the sense comparator stage. A second comparator stage will sense when the output of the first stage rises above 3.3 volts. The turn on delay results in a maximum chopping frequency of 20 kHz. The lowest chopping frequency is a function of the motor current, at a maximum motor current of 240 milliampere, the chopping frequency is 14 kHz. Inserted between the sense resistor and the comparator input is an RC network needed for filtering of the short circuit current caused by the distributed capacitance of the motor winding.

d. The chopping action results in a steady state current in the winding for a given phase duration. When the phase is reversed the opposite high side and low side switch will turn on. This forces current to flow in the opposite direction. The reference, MTR_I1 (*MTRA_I_1*), is controlled to ramp the motor current exponentially, this minimizes step oscillation, reducing mechanical noise.

The following table illustrates the phase sequence and the respective power, high side and low side switches that are enabled. Refer to schematic for signal references.

Table 4-3. Motor Control Signals

Control Signal Logic	Logic State	Active Switches	Winding Effected
MTR_EN_1	H	Q4-6, Q3-1	
MTR_PH_1	L	(*Q17-6*), (*Q19-3*)	MTR_1A/B
MTR_EN_2	H	Q6-6, Q5-3	
MTR_PH_2	L	(*Q8-6*), (*Q10-3*)	MTR_2A/B
MTR_EN_1	H	Q4-7, Q3-3	
MTR_PH_1	H	(*Q17-7*), (*Q19-1*)	MTR_1A/B
MTR_EN_2	H	Q6-5, Q5-1	
MTR_PH_2	H	(*Q8-7*), (*Q10-1*)	MTR_2A/B

To assist the down stream pressure algorithm and reduce mechanical noise the motor is stepped in packets, a series of motor steps followed by a short resting period.

e. The efficiency of the motor driver is determined by the low on resistance in the Mosfet switches, and the speed at which they are switched on and off. Since only the high side switches are involved in regulating the motor current, a bipolar network has been designed around these switches to keep switching times below a microsecond. An example of a switching sequence is described as follows.

To activate the following circuit requires MTR_PH_1 (*MTRA_PH_1*), MTR_EN_1 (*MTRA_EN_1*), and WD_OUT* to be at a logic high. When the second comparator output U14-7 (*U27-1*) switches low, this turns on transistor Q18 (*Q23*), which turns off Q4 (*Q1 7*) immediately, thereby removing the motor voltage away from the motor winding. When U14-7 (*U27-1*) switches high, this causes the output of comparator U13-7 (*U25-1*) to switch low and transistor Q18 (*Q23*) to turn off, this quickly turns on Q4 (*Q17*). A 1000 pF capacitor is in series with the output of U13-7 (*U25-1*) to speed up the switching time of Q4 (*Q17*) when the comparator output goes low.

Two motor current sense comparators are included in the motor drive circuit to provide a means for the instrument to detect that an instrument malfunction that results in a "watchdog" alarm will shut off current to the motor. The signal WD_OUT* when at a logic low is the indicator for a "watchdog" alarm. When motor current of approximately 20 milliampere or greater flows through either motor winding the motor current sense comparator output MTR_SNS* U12-7/U12-1 (*U17- 1/U17-7*) will be at a logic low. Both motor windings would have to have a motor current of less than 100 milliampere for the motor current sense comparator output to go to a logic high.

Figure 4-9 Motor Drive Circuit, Phase 1(A)

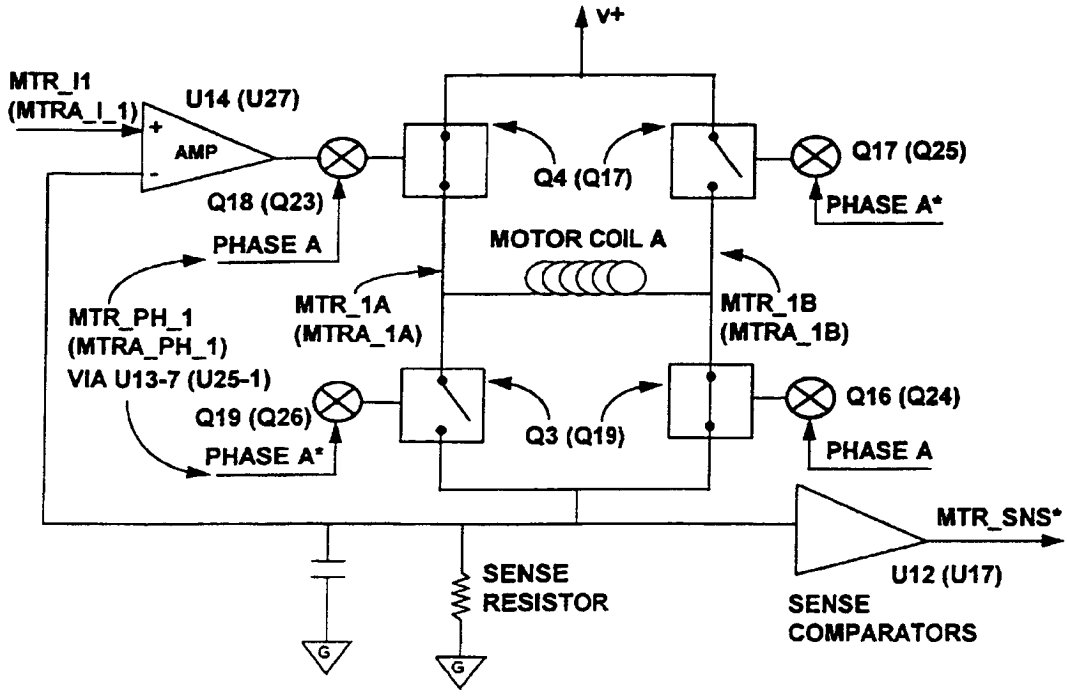
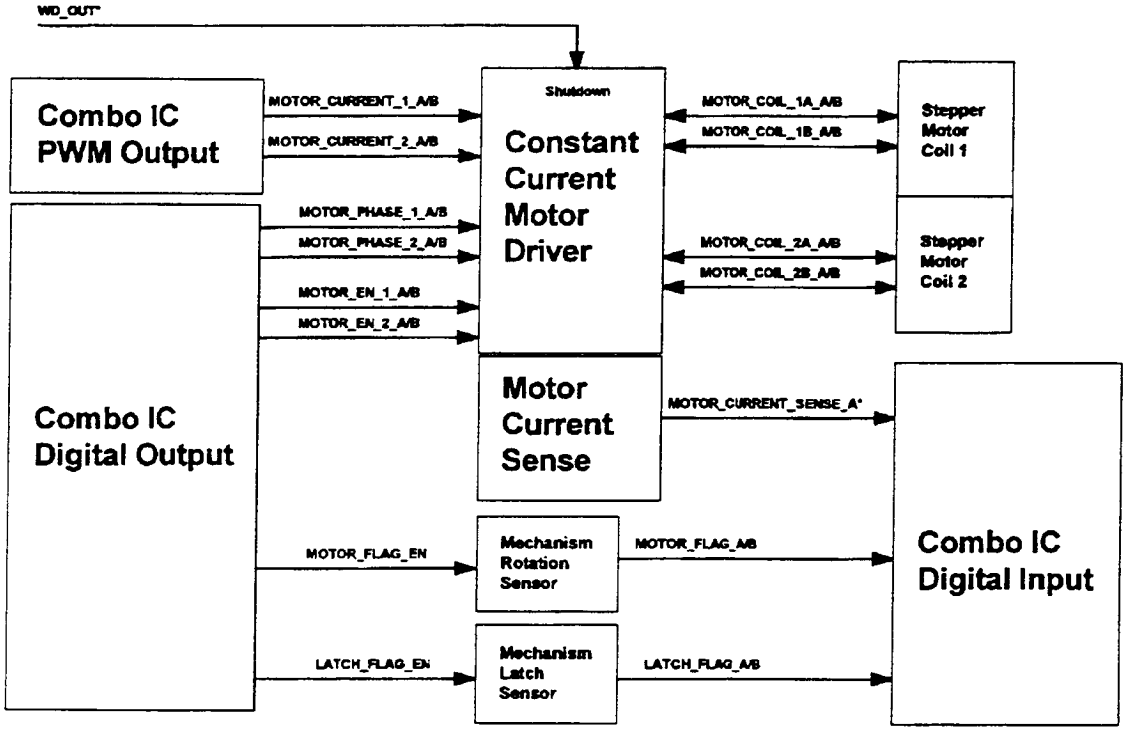


Figure 4-10 Motor and Mechanism Sensors Block Diagram



4.6.2 Air-In-line Sensor

The Air-in-Line (AIL) Detector System consists of a:

- Transmitter arm that also loads the set in position to monitor for air.
- Receiver which is mounted in the mechanism.
- Voltage control oscillator (VCO).
- COMBO IC and associated circuits.

The voltage control oscillator will sweep a frequency range of 1 to 4 MHz and serve as the excitation for the ultrasonic AIL transducer. This frequency sweep is necessary to ensure that the piezoceramic elements will achieve resonance over assembly and temperature variances. The AIL Gate signal will initiate the VCO to sweep. The detector is scanned at a 10 msec rate (40 msec to check bubble) and once a second to test the AIL hardware.On the receiver side, the signal envelop will be seen if fluid is in the set. This signal is then returned to the COMBO IC and eventually to the processor to determine if air is present (no signal) and to compute the size of the air bubble. The instrument will consider air bubbles separated by less than 70 microliters of fluid as one bubble and alarm accordingly.The instrument will also alarm if 10% to 15% of downstream tubing is filled with air (varies with alarm set point).

4.6.3 Transducer

The transducer assembly is a silicon based resistor bridge producing a linear output. The sensing area is in the front of the assembly and directly in contact with the tubing (no gel). It is used to measure stress not absolute pressure. A film over the transducer provides a means to protect the sensor from electrostatic discharge. At least 1 hour is required for the transducer to stabilize to room temperature.

The transducer is used to sense upstream and downstream occlusions as well as sensing if the set is installed or removed. To accomplish these tasks the transducer is calibrated with a special set. The pressure calibration set has a hole drilled into the dome of the AccuSlide. This enables the pressure to be applied directly to the transducer for calibration (0 and 500 mmHg). Temperature compensation (factory set) of the pressure reading is also done and stored in a section of the diagnostic mode.

After pressure calibration, the reading shown in the diagnostic mode for the sensor is corrected for any offset /stress from loading the set outside of the pressure sensing area.

When the set is installed, with dome intact, the instrument looks for an increase in stress (greater than 55 mmHg with auto zero enabled, >90 mmHg

Figure 4-11 Air-in-line Detector Block Diagram

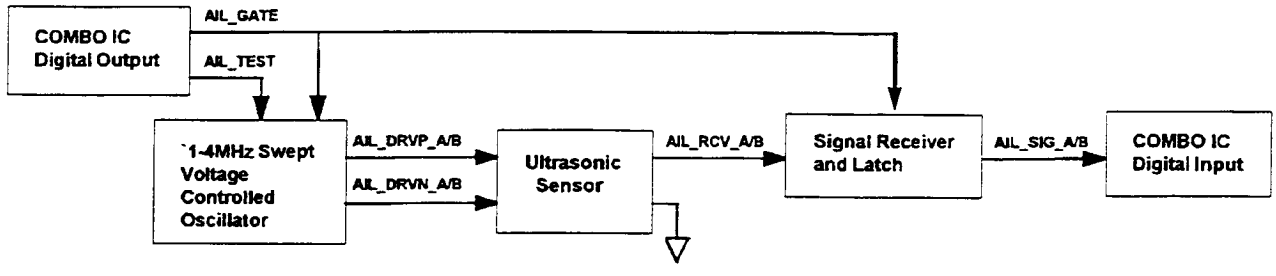
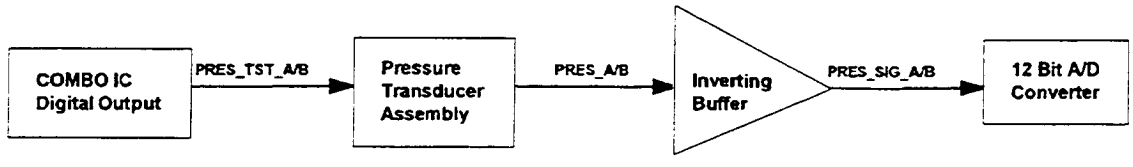


Figure 4-12 Pressure Sensor Interface Block Diagram



with auto zero disabled). Drift is checked periodically to ensure the transducer is accurate. If not, a "Cal Reqd" message will appear. This is done by asking the operator to remove the set before powering down the instrument. The time period of this test is selectable in the diagnostic mode under the Self Check timer.

PRES_TST_A/B is used to take the transducer out of balance by inducing a known positive offset. This is the means by which the transducer is tested.

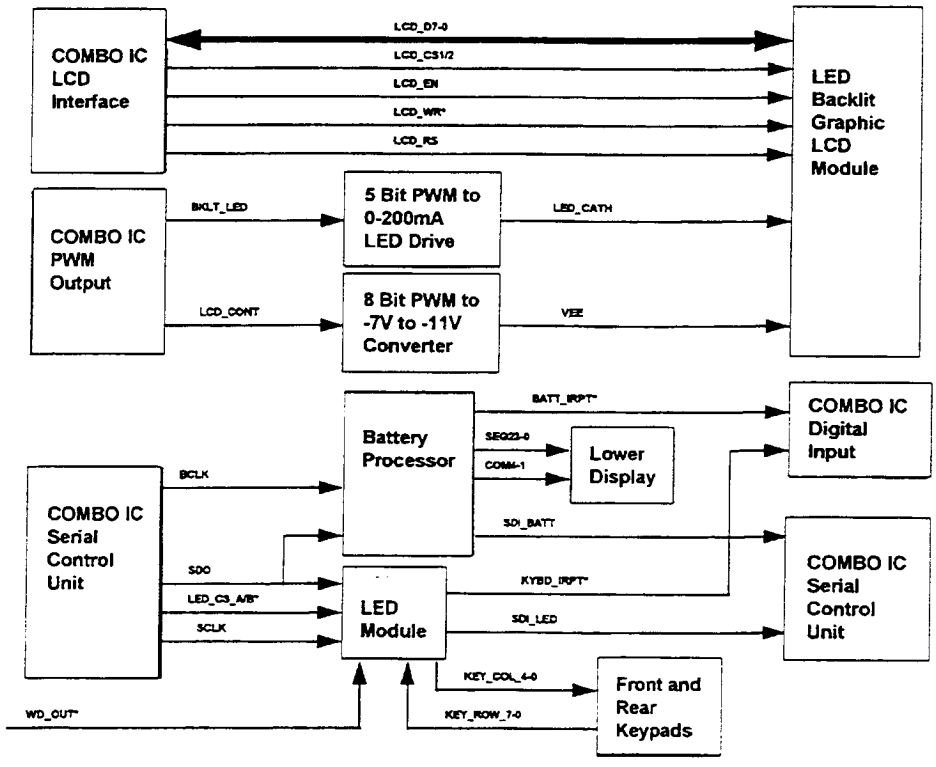
The "Cal Reqd" message will appear if transducer shifts more than 170 counts positive or 200 counts negative from last "0" cal level.

4.7 User Interface

The user input interface consists of a keyboard organized as a 5x8 matrix which is scanned and controlled through the LED Module on a single channel pump and the Channel A LED Module on the dual channel pump. The keyboard is scanned approximately every 10 ms and key data updated when there is a change due to any key or keys being pressed or released. Note that the panel lock is scanned as part of the scan sequence even though it is located on the back of the pump. Switches are scanned every 10 msec., two cycles are required to be a true switch actuation. This provides a debounce function to eliminate mechanical noise and EMI/RFI interference. The power switch(es) are sensed separately by the Battery Manager. During normal operation, the power switch(es) are monitored like the other keys so that inadvertent pump turnoff can be avoided. In a system alarm state (i.e., watchdog alarm active), the keys directly control turning power off to the pump.

The user output interface consists of three display modules. The LED Module(s) provide rate data visible from a distance, along with operating mode annunciators, AC/Battery operation notice, and visual

Figure 4-13 User Interface Block Diagram



alarm indication. The Graphic LCD Module provides user information on a 128x64 dot matrix display with LED back light. The Lower LCD display shows the current battery run time along with the current audio level selected, communications interface status, panel lock status, and battery refresh status.

4.7.1 Main Speaker Driver

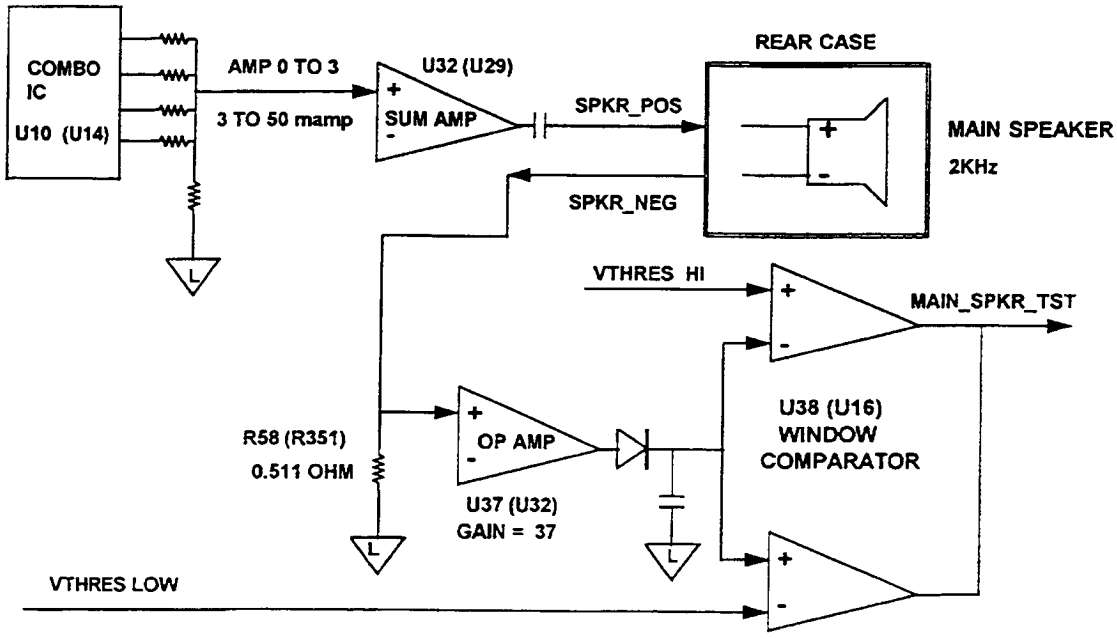
The main speaker driver is based on an LM386 low voltage speaker drive chip, U32 (*U29*) driven by an exponentially weighted 4 bit control signal (AMP 0 to 3) modulated at the desired frequency (200 Hz - 4 kHz) by the COMBO IC U10 (*U14*). The speaker is pulsed at 3 to 50 mA with a 50% duty cycle (max. 100 mA). The driver has a fixed 26dB gain which provides up to 3Vpp AC coupled into an 8Ω speaker. The speaker is tested by monitoring the speaker current with a 0.511Ω resistor.

The voltage across the resistor is amplified, rectified, and compared to low and high threshold values by a window comparator, U38 (*U16*). The speaker is tested when an alarm or error occurs, while the test circuit is verified at power up. The speaker audio volume settings are approximately: Low= min 45 dB, Med= 65 dB, and Hi= approx. 70 dB.

4.7.2 Backup Audio Buzzer and Test Circuit

A backup audio generation capability is provided to allow the instrument to generate an audible alarm in the event that the main speaker is unable to do so. It is supplied through VBKUP, a 1.0 Farad "supercap" C146 (*C179*) energy storage device charged by a 5V linear regulator, U32 (*U44*) on the VAO_SOURCE supply. The buzzer is a self oscillating audio generator and speaker module which produces a 3 to 4 kHz tone when energized. A logic circuit, U30 (*U41*) powered by VBKUP arms the circuit using the BKUP_ALARM_ARM signal once the instrument has powered up so that the watchdog WD_OUT* signal will not generate an alarm if the unit is turned on or

Figure 4-14 Main Speaker



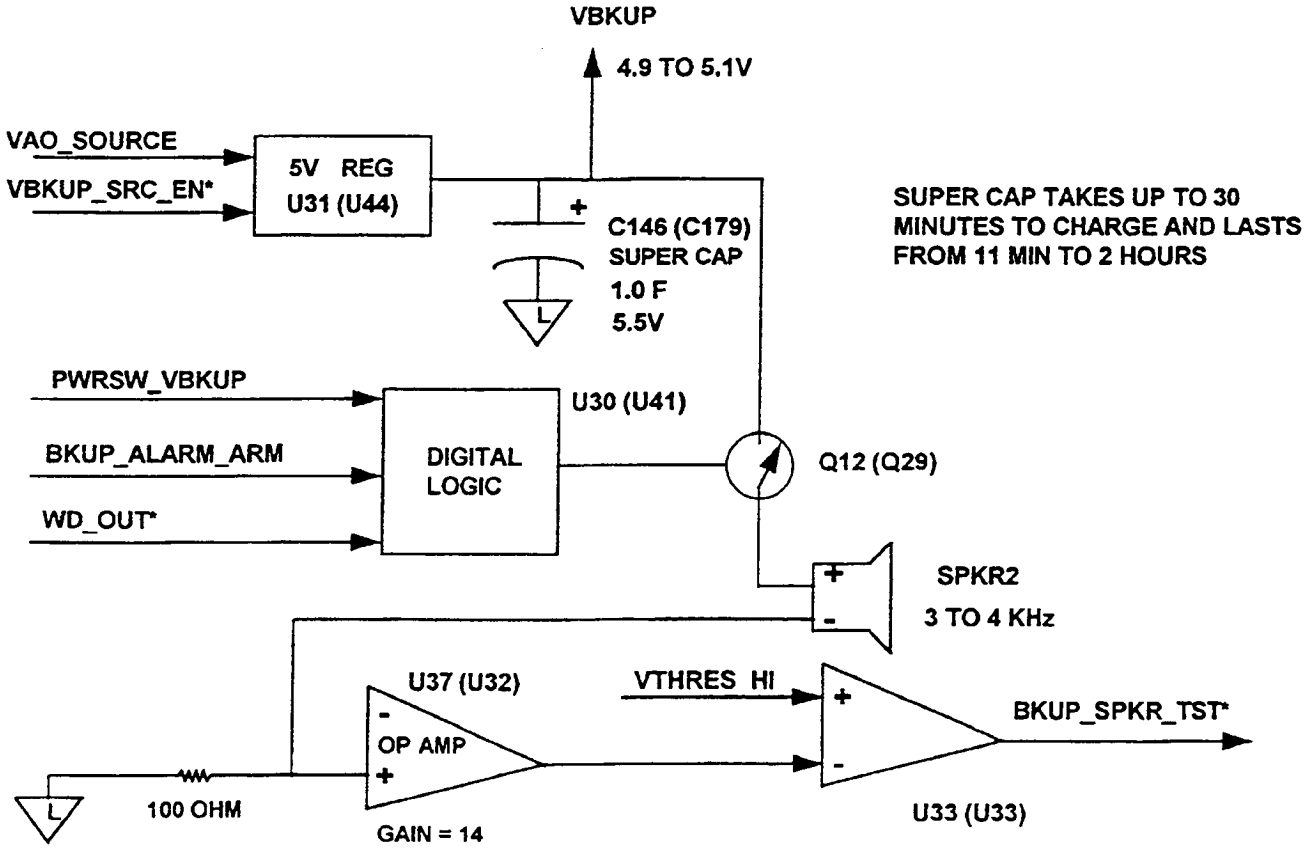
off properly. Additional logic is provided to allow the power switch(es) to turn off the backup audio if the main CPU or battery processor no longer have control over the instrument.

The circuit has two test functions. The VBKUP supply is tested at power up to verify that the supercap can drive the buzzer when the regulator is disabled through VBKUP_SRC_EN signal. The buzzer operation is tested by sensing the oscillating current waveform generated by a normally operating buzzer. The buzzer current is sampled by a sense resistor, whose voltage is amplified. The DC level is compared to VTHRES Hi by a comparator, U33 (*U33*), whose output (BKUP_SPKR_TST*) drives a digital input on the COMBO IC.

4.8 LED Module

The LED Module(s) provide rate data, along with operating mode annunciators, AC/Battery operation notice, and visual alarm indication. The modules have 58 individual LEDs controlled by a custom IC. The IC performs LED scanning and test functions along with keyboard scanning circuits and interfaces to the main CPU through the local serial interface. The LED intensity is controlled by the main processor to limit power use while running on battery.

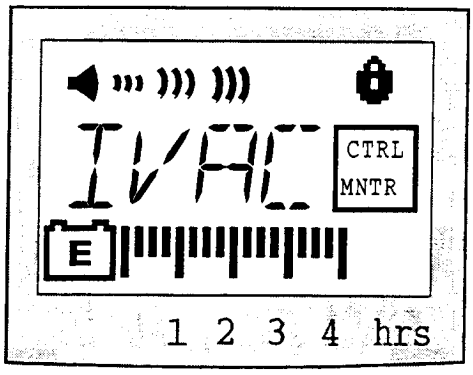
Figure 4-15 Backup Audio



4.9 Lower LCD Display

The Lower LCD Display is visible whether the pump is on or off, AC or battery operation. It shows the current battery run time available along with the current audio level selected, communications interface status, panel lock status, and battery refresh status. It is driven by the Battery Manager and is back lit when the pump is on or plugged into AC.

Figure 4-16 Lower LCD Display Layout



4.10 Main LCD Module

The Main LCD Module provides user information on a 128x64 dot matrix display with LED back light. The main processor generates all text and symbols in bit mapped form, then compares data read back from the display memory to that which was generated to find and avoid problems. Screen updates occur every 100 mSec. The back light intensity is controlled by the main processor to limit power use while running on battery. The LCD contrast is controlled by the main CPU and can be adjusted from factory default through the diagnostics mode. Refer to Section 6.4.16 "Changing Main LCD Contrast".

4.10.1 Main LCD Back Light

The graphic LCD backlight is an array of LEDs driven by an adjustable constant current source controlled by a PWM signal from the COMBO IC. The LED current can be adjusted stepwise linearly over a 0-200 mA range. The current source consists of a low on resistance FET, 0.511Ω sense resistor, and op amp to set the sense resistor voltage based on the filtered PWM input voltage BKLT_LED. The backlight intensity is not user adjustable.

4.10.2 Graphic LCD Contrast

The graphic LCD contrast is controlled by varying the Vneg supply to the module over a -7V to -11V range. The drive circuit inverts and scales the filtered PWM LCD_CONT signal from the COMBO IC to cover this range. Nominally, the contrast voltage is -9V, but can be adjusted through Configuration Mode in software.

4.11 Nurse Call Circuit *(7100/7200 only)*

An optional nurse call circuit is located on the RS-232/Nurse Call board and provides a 35V @ 1A rated relay contact on system alarms through pins 6 and 9 of the RS-232 connector.

4.12 Panel Lock Switch

The pump can be protected from unauthorized changes with the Panel Lock Switch. A lock symbol is shown in the Lower LCD Display whenever the feature is active. When activated, access to all front panel keys is restricted (except channel select and split screen viewing key).

4.13 ECD Board

4.13.1 ECD Board Option for 7100/7200

The ECD board (sold in a separate kit) provides empty container detection using standard IVAC Model 180 Drop Sensors. The board contains two independent drop sensor control circuits and drop detection circuits as well as timing control logic. The circuitry can detect whether a drop sensor is installed and generates a ~20 ms pulse for each drop detected. Note that, for SE I use, the second channel is not used.

4.13.2 ECD Board Option for 7101/7201

a. *Overview* The flow sensor interface is a separate PC board which drives a standard IVAC 180 optical flow sensor, performs ambient light rejection on the resulting signals, and provides digital output signals for a detected drop and sensor attached detection. The board consists of 2 separate ambient light discriminator loops and

drop detectors for independent Model 180 flow sensors along with common timing and control logic. The board assembly is common to both single and dual channel instruments, where the "B" channel is not available externally and is ignored in the software of the single channel instruments. Note that the "A" channel is used for both the "A" channel in the dual channel instrument as well as the single channel instrument, even though the mechanisms are on opposite sides of the case.

b. *Common Timing Logic* The common timing and control logic generates the necessary discriminator timing signals to drive the flow sensor LED and sample signals representing room ambient light and LED driven light outputs from the flow sensor. The main system CLK_32KHz is used as the timebase and decade counter U3 that generates non-overlapping "A" and "B" channel drive and sense signals. This reduces the peak LED current load and flow sensor crosstalk during normal operation. Transistors Q5 and Q6 provide logically inverted control signals for the LED drive circuits.

c. *Ambient Light Discriminator Loop* The flow sensor drive current is set to maintain a 2.8V level normally at DROP_A/B. This level is determined by the difference in input signal from a 180 drop sensor when the emitter is undriven and driven. Analog multiplexor U4 normally grounds the output of the sense capacitor C18/23 so that room ambient light signal voltage is set across it. When the LED drive is turned on, the output of the sense capacitor, representing the driven signal voltage less the ambient signal voltage, is transferred to sample cap C28/C26. This signal is amplified by U8/U7 with a gain of about 23 and is the DROP_A/B signal.

The DROP_A/B signal is sensed by integrator U1/U6 and C9/C10 to generate an appropriate LED drive level to maintain DROP_A/B at about 2.8V. The integrator output signal is controlled by drive enable FET Q1/Q2 to drive the LED constant current sink U1/Q4 and related components. The constant current source generates a 0-200mA sink current with a 0V-1V input signal.

To prevent a drop even from skewing the LED drive signal, a long time constant filter, consisting of CR1/CR2, R31/R13, and C9/C10, is enabled on a negative going output signal DROP_A/B.

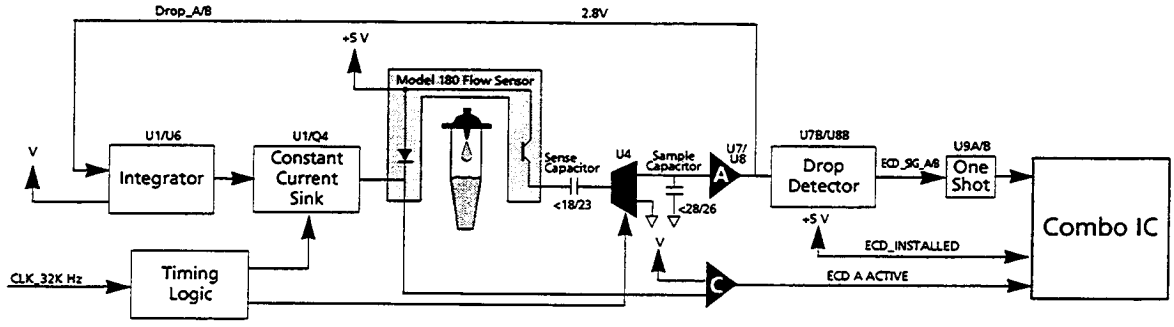
d. *Drop Detector* The drop detector circuit generates a digital pulse when a valid drop event is detected. A drop event occurs when a fluid drop passes between the emitter and detector of the Model 180 drop sensor and appears as a generally negative going short duration pulse on the DROP_A/B signal. Detector comparators U8B/U7B generate a 0 to 5V pulse when a drop "signature" of appropriate length and duration occurs. One shots U9A/B generate a nominal 20 ms pulse which indicates a valid drop (ECD-SIG-A/ECD-SIG-B). The main system processor processes the pulse stream and determines whether the drops are occurring properly for the current instrument rate and operating mode (i.e. primary/secondary).

EMC filtering is provided by filters C4-8 to limit energy into or out of the flow wensor connecxtion pins.

e. *Option Installed and Sensor Installed Circuit* The installed option detection consists of the input signal on pin 7 of J3 tied to +5V on the board. The main processor has a pulldown resistor on the ECD_INSTALLED signal which generates a logic low signal if the option is not installed. Flow sensor installed signals are generated by monitoring the LED current sink drive transistor collector voltage. Comparator U2A/U2B monitor the voltage and generate a 5V output signal if they drop below about 1.7V. Note that, nominally, the collector voltage should not go below about

2.2V with a flow sensor attached and driven at maximum current.

Figure 4-17 Flow Sensor Interface Block Diagram



Chapter 5 — CORRECTIVE MAINTENANCE

Due to product changes over time, some components/assemblies depicted in this chapter may differ in appearance from your instrument.

5.1 Introduction

This chapter contains procedures required to properly disassemble, repair, and replace parts as well as to test, calibrate, and reassemble an instrument if a problem is detected. Included in this chapter is a list of test equipment required to perform these functions. Table 5-1, "Test Equipment", lists equipment required for normal checkout or maintenance of the volumetric pump. Table 5-2, "Level of Testing Guidelines", provides tests for various levels of repair.

A thorough familiarization with the function and operation of the mechanical assemblies and electrical circuits of the pump will enable repair, replacement, and calibration to be accomplished more efficiently (refer to Chapter 4).

Table 5-1 Test Equipment

NAME	MANUFACTURER	MODEL NUMBER	APPLICATION
Electrical Safety Tester	BIO-TEK	260*	Used to test AC wiring and pump grounding.
IV Infusion Set	IVAC	70 RCS	Rate accuracy test.
Nurse Call Cable	IVAC	136111	Nurse call option
Pressure Cal Set	IVAC	70ISS	Pressure verification and calibration.
Pressure Gauge (-400 to +750mmHg)	Dresser Industries — 203-426-3115 (Heise) BIO-TEK— 802-655-4040	PTE1/901M1 DPM III	Pressure calibration and verification
Burette 50ml, 0.1 ml increment	Fischer Scientific Kymex	Class A or B* 113 Sec A*	Rate calibration and verification.
RS-232 *(9-pin, Null Modem)*	IVAC	133450*	Connects between 2 instruments to download configuration.
Silicon Tubing	IVAC	303109*	Pressure Calibration Setup
T-Fitting	IVAC	303815*	Pressure Calibration Setup.
Nicd Battery Optimizer	Alexander Batteries— 800-577-2539	Model 2006* 2003	Test and condition batteries. (optional)
Permanent Ink Marker (Orange)	Metron— 619-755-4477	P3*	Pressure Calibration (hard)

* *or equivalent*

5.2 Repair or Replacement

ALARIS Medical Systems recommends that parts within the pump be replaced rather than repaired when not working properly. Boards, mechanism and display modules must be replaced as an assembly. See Chapter 7 for parts available and level of replacement possible.

NOTE: The tests to be performed on a just-repaired instrument depend on the level of repairs made to the pump. See Table 5-2, Level of Testing Guidelines.

5.3 Replacing Battery

You will need a Phillips screw driver to remove the battery.

NOTE: Instrument configuration will not be lost when disconnecting power. However, error history and infusion program settings may be lost. If you want to save error history, record before proceeding.

1. Disconnect AC power from the instrument.
2. Remove screw from Power Cord Retainer, on rear case, using a Phillips screw driver.
3. Remove Power Cord and Power Cord Retainer.

CAUTION: When there is no AC power available, do not replace dead battery for the purpose of re-powering the instrument. The instrument will not operate unless it is first connected to AC power after battery replacement.

4. Lift and remove Battery Cover.
5. Lift cable for battery out of compartment.
6. Pull battery from compartment and disconnect.

NOTE: The instrument will not run with battery disconnected.

7. Connect and install new battery. Note the rated capacity of the new battery.
8. Reassemble the battery cover, power cable and power cord retainer.

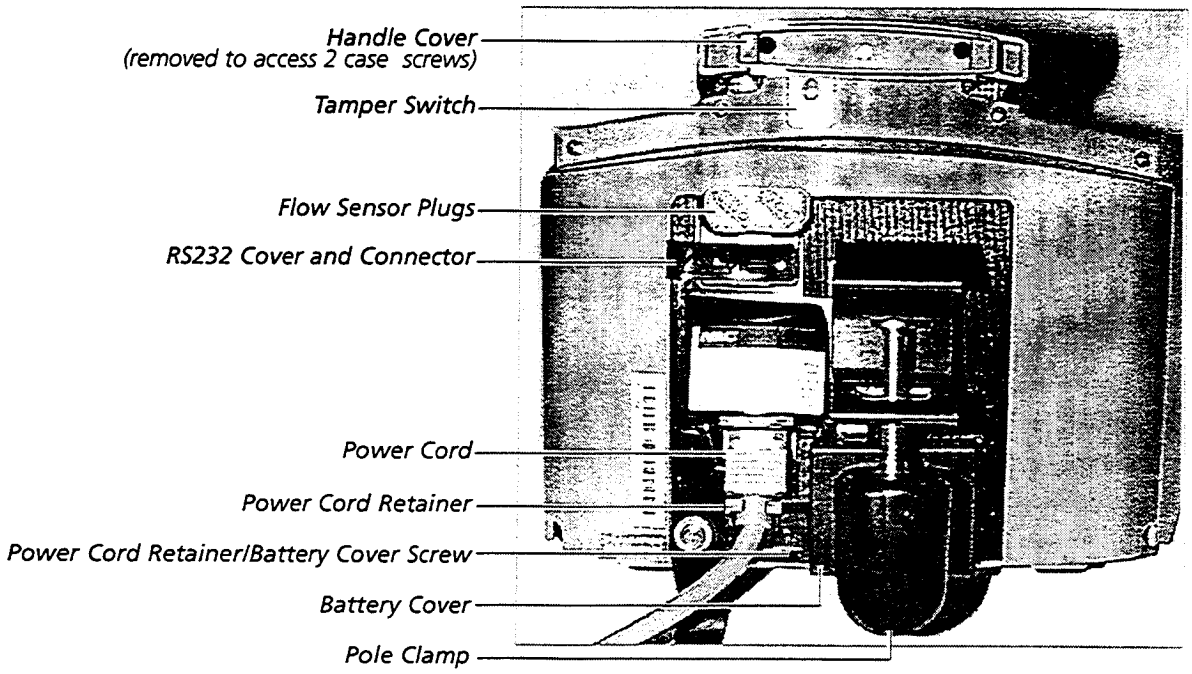
The replacement battery may have a different rated capacity (current battery has rated capacity of 1.8 AH, with 1.3 AH entered in Diagnostics Mode). If it does, proceed to the Diagnostics Mode (D2), select Battery Status and enter new rated capacity. Refer to Section 6.4.6 "Changing Rated Capacity of Battery".

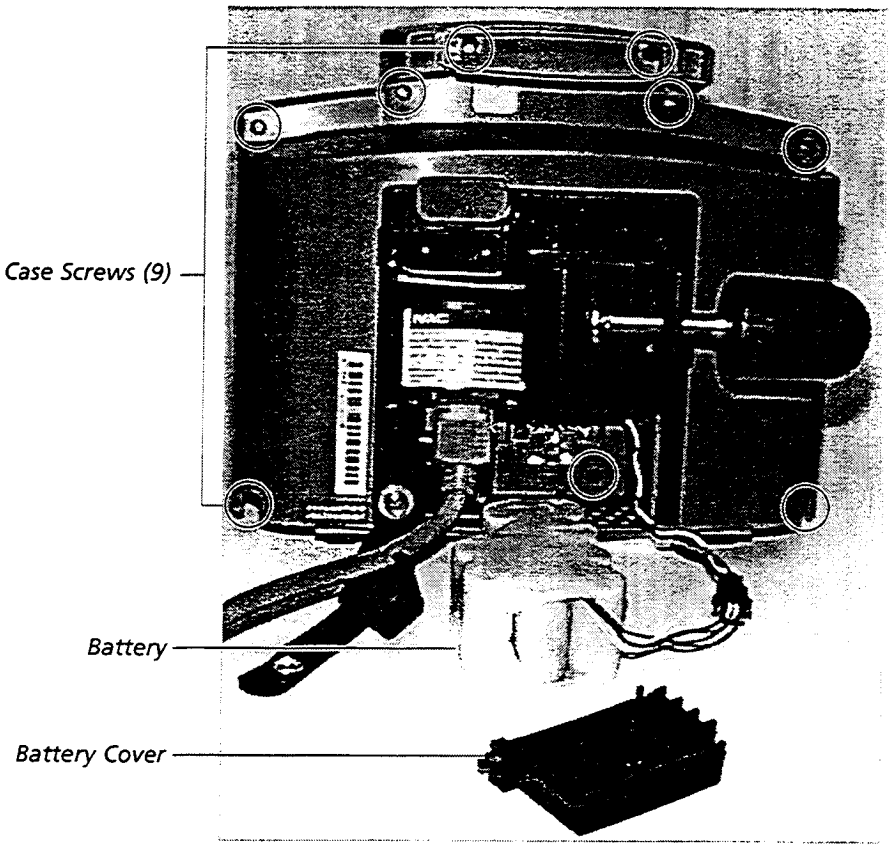
In the future, ALARIS Medical Systems may provide different battery packs. The battery manager needs to know if a new battery, possibly with a new rated capacity, has been installed.

9. Clear battery run time via Diagnostics Mode after installing new battery. Refer to Section 6.4.9 "Viewing Battery and Total Run Times".

Battery replacement is now complete.

NOTE: The instrument will attempt to refresh the battery when it is first installed and connected to AC power. This refresh may take in excess of 24 hours if the instrument is turned on.


Handle Cover
(removed to access 2 case screws)
Tamper Switch
Flow Sensor Plugs
RS232 Cover and Connector
Power Cord
Power Cord Retainer
Power Cord Retainer/Battery Cover Screw
Battery Cover
Pole Clamp


Case Screws (9)
Battery
Battery Cover

5.4 Disassembling the Pump

Gaining access and removing various components of the pump for replacement is simple. It may not be necessary to disassemble the entire pump to replace a component. Figure 5-1, "Instrument Assembly Organization", provides the instrument's assembly hierarchy. Also refer to Chapter 7 for assembly drawings. A more detailed description on *how* to disassemble the instrument follows.

You will need a Phillips screw driver, 3/16" socket wrench, 3/8" socket wrench, and 3/32" (or 2.5 mm) allen driver to separate both case halves and disassemble the pump.

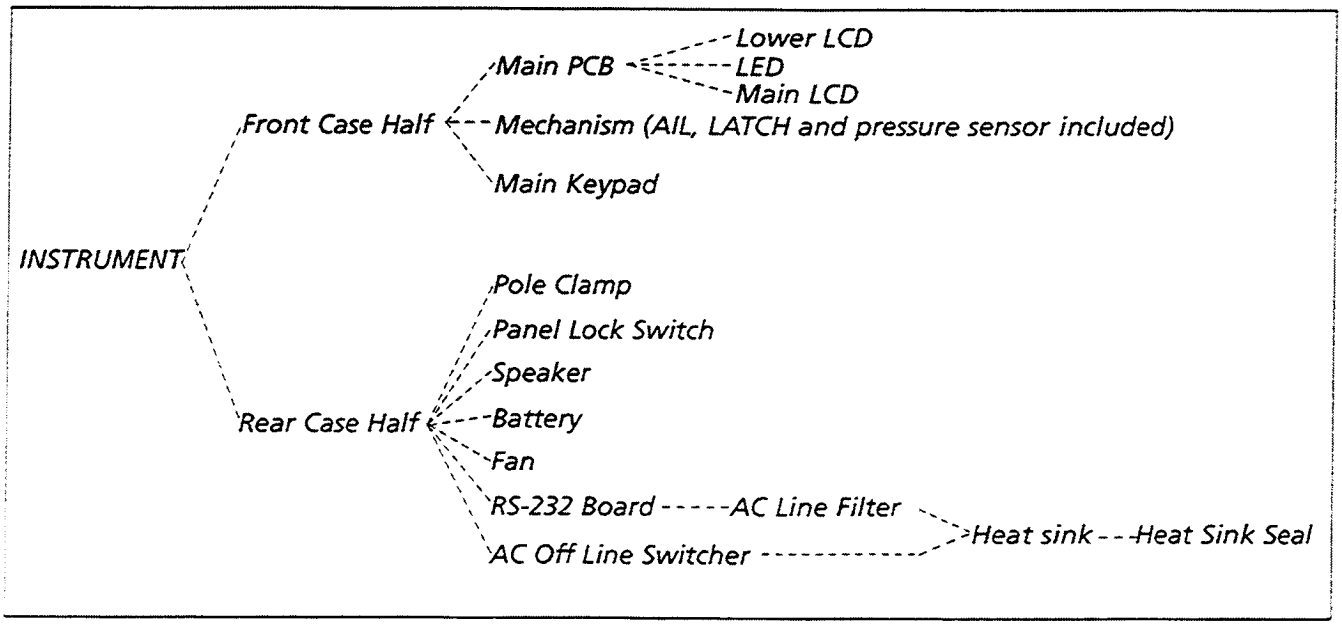
NOTE: Instrument configuration will not be lost when disconnecting power. However, history and programmed settings may be lost. If you want to save event log, record before proceeding.

Though a dual channel pump is depicted in the following procedures, both instruments disassemble in the same manner. Channel B will be the same as a single channel instrument.

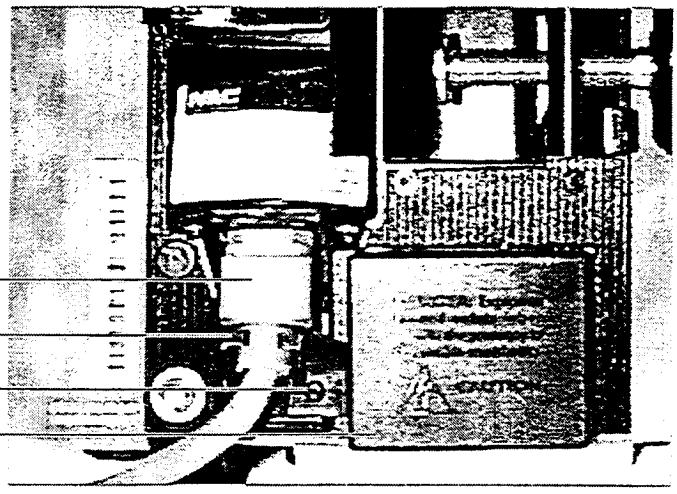
WARNING: *Disconnect pump from AC power before disassembling. Hazardous voltages are present when AC power is connected regardless of the setting of the POWER switch.*

CAUTION: *To avoid serious damage to the board assemblies, use extreme care and always use proper static grounding techniques.*

Figure 5-1. Instrument Assembly Organization

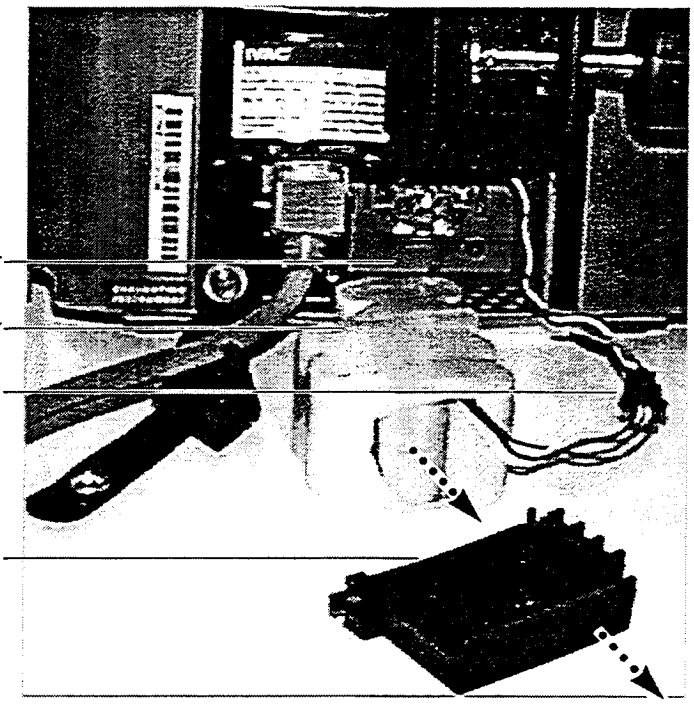


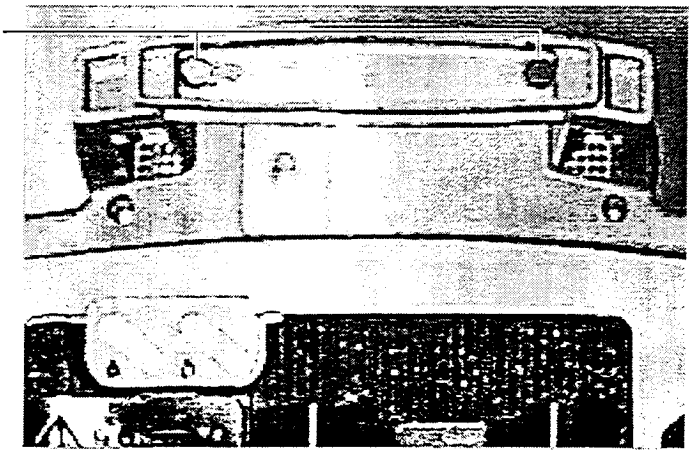
1. Using a Phillips screw driver, remove screw from Power Cord Retainer on the rear case, then remove the power cord and power cord retainer.
2. Lift and remove the battery cover.



3. Pull battery from battery compartment and disconnect the battery.

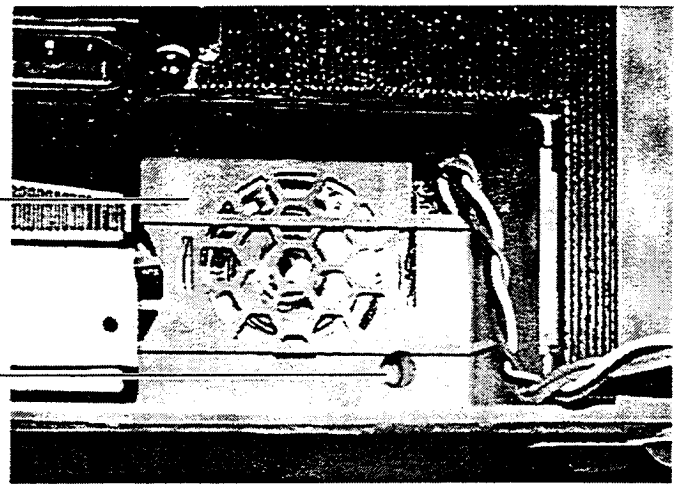
NOTE: If replacing battery, ensure battery run time is cleared in Diagnostic Mode.



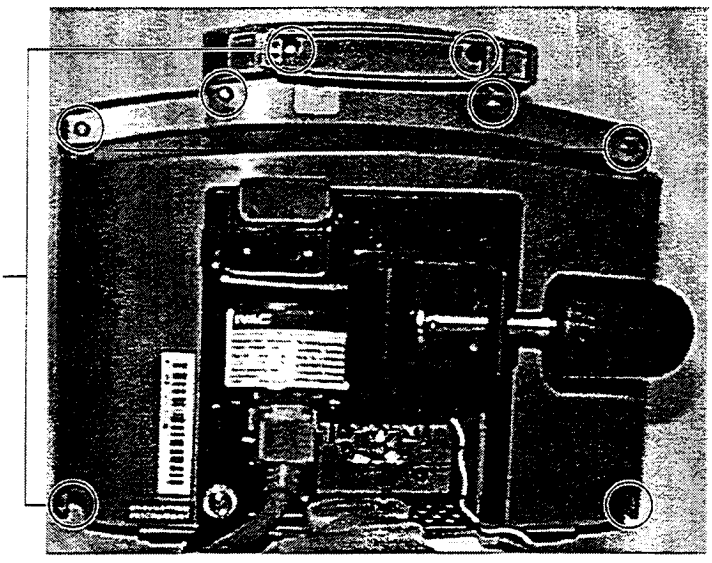


4. Press on cutouts to pop off cap for handle from inside (between handle and case) to access two screws to open unit. Remove the two screws using a Phillips screw driver.

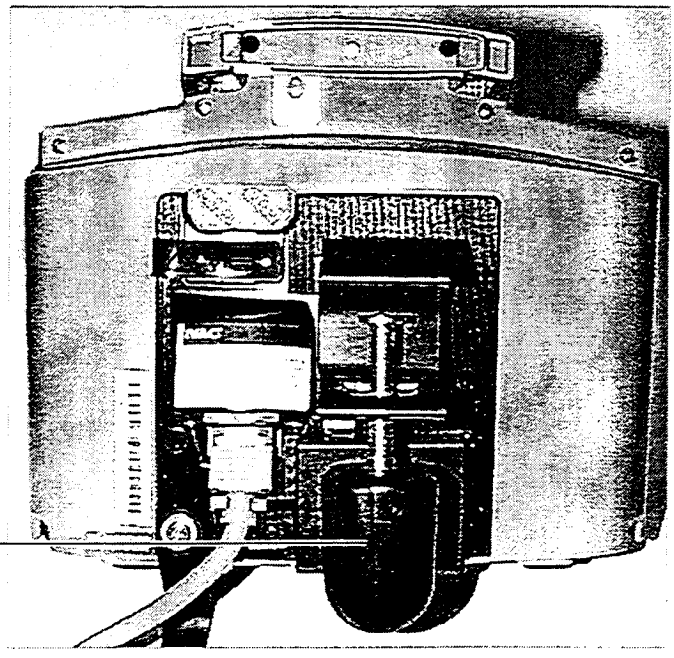
5. Remove the battery to get the hidden case screw inside the battery compartment. Remove the screw.



6. Remove remaining case screws (6 for dual, 4 for single).



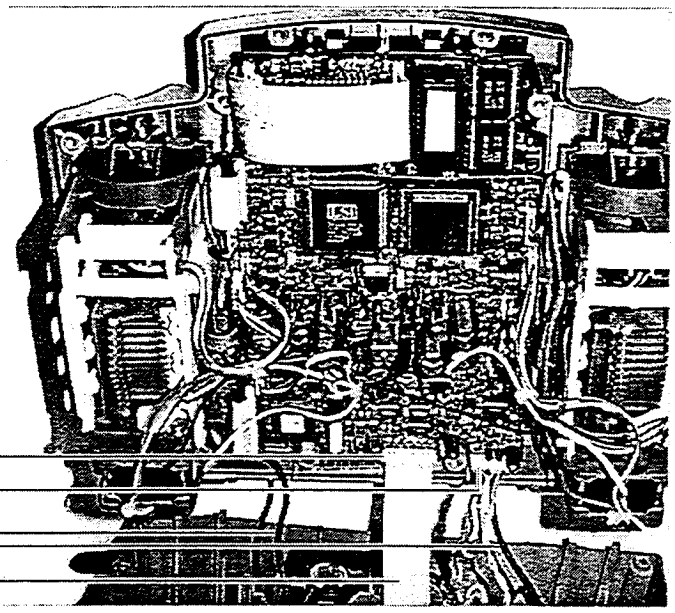
7. Lay pump face down.
8. Position pole clamp knob down.
9. Lift rear case to access the inside of the pump.



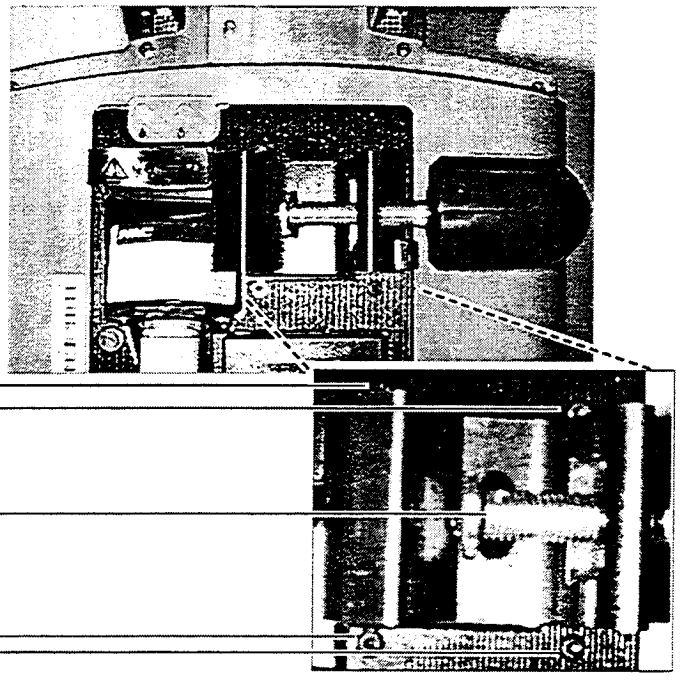
5.4.1 Disassembly of the Rear Case

1. Disconnect power supply board connector/battery cable. Lift up the locking bar and remove the RS-232 flex cable from front case. Disconnect ground wires (1 for single channel) from under motor.

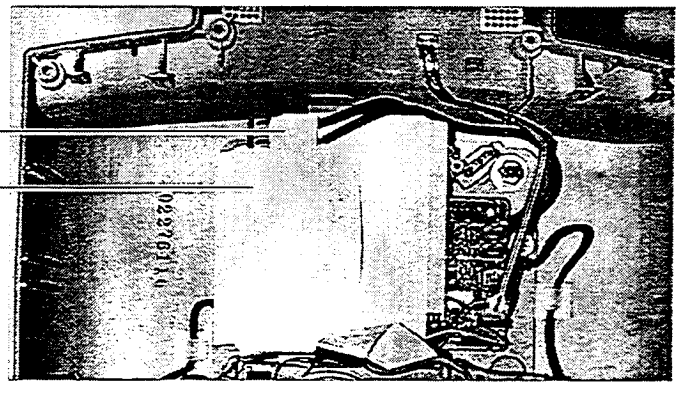
   • The rear case is now completely separated from the front case. Set front case aside.



2. To replace the power supply board assembly: remove the four screws from Heat Sink using Torx 3/32" (or 2.5mm) driver to separate power supply board from the inside of the rear case. Disconnect the cable from the power supply board.

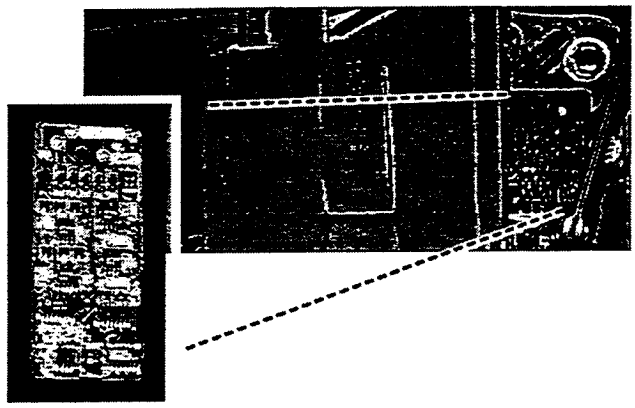


NOTE: Do not remove cover from back of power supply board. If it's loose, reinstall with RTV.



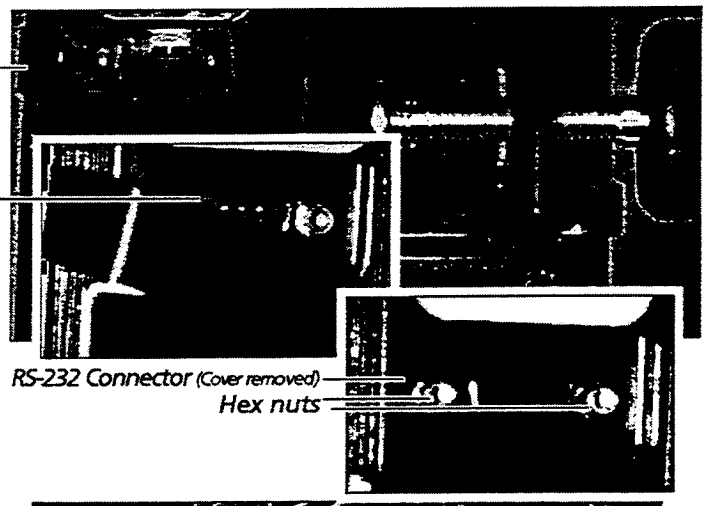
3. **To replace ECD board assembly *(if installed)*:**

   a. Remove screw on ECD board using Phillips screw driver, then remove the RS-232 board.



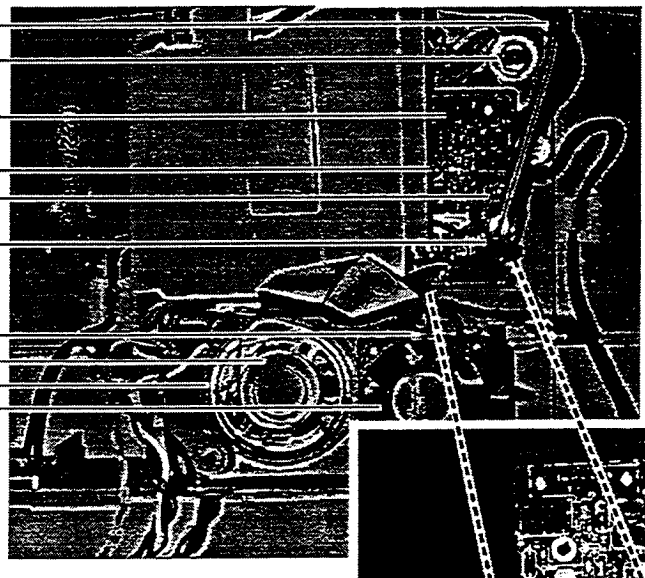
4. **To replace RS-232 board assembly:**

   a. Pull the RS-232 cover away from the connector then remove two hex nuts using 3/16" socket wrench.

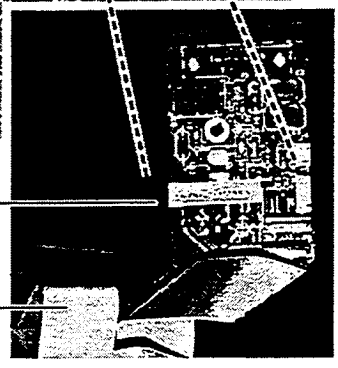


   b. Disconnect the Panel Lock Key Pad flex cable by lifting up on locking bar.

   c. Disconnect speaker and fan from RS-232 Board.



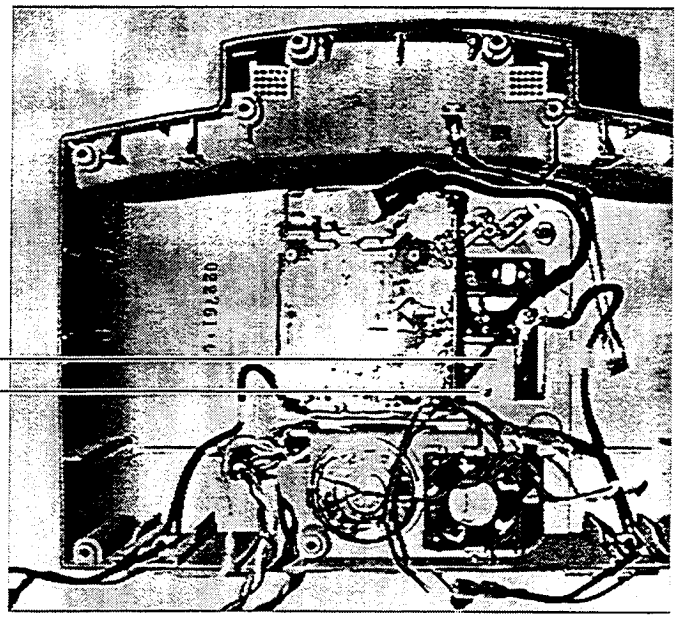
   d. Remove screw on RS-232 board using Phillips screw driver, then remove the RS-232 board.



5. **To replace the line filter:** remove screw from Line Filter using Phillips screw driver.

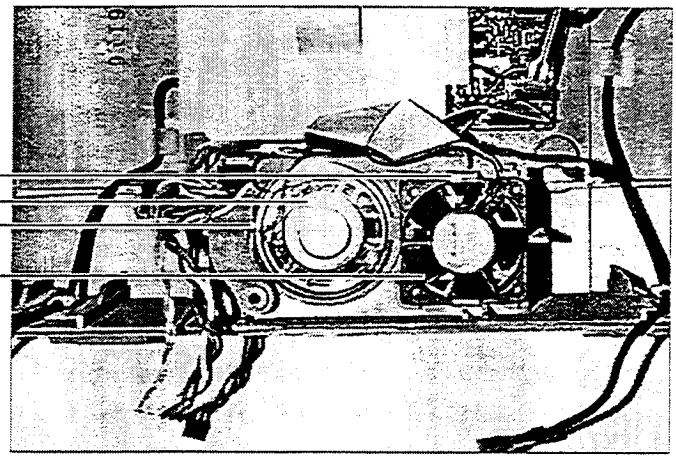
   Remove two screws from exterior power connector using Phillips screw driver.

   Remove exterior power connector and Line Filter assembly.



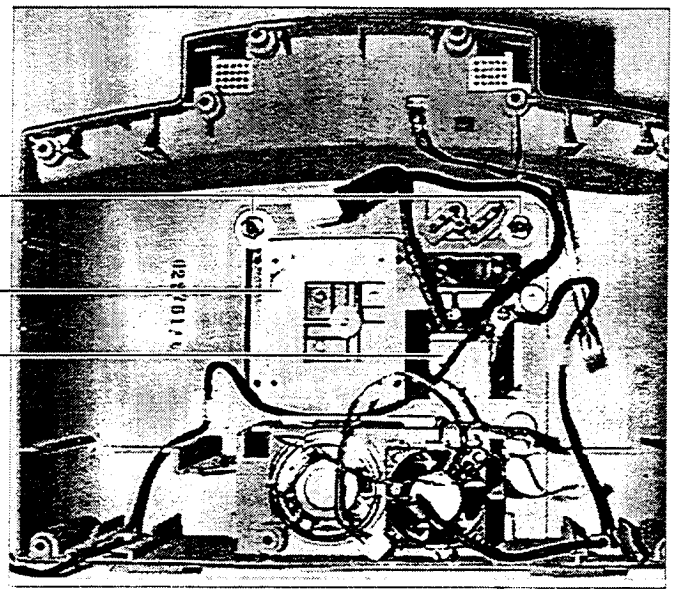
6. **To replace speaker/fan assemblies:** spread clips and remove the fan or speaker.

   Disconnect from RS-232 Board, if necessary.



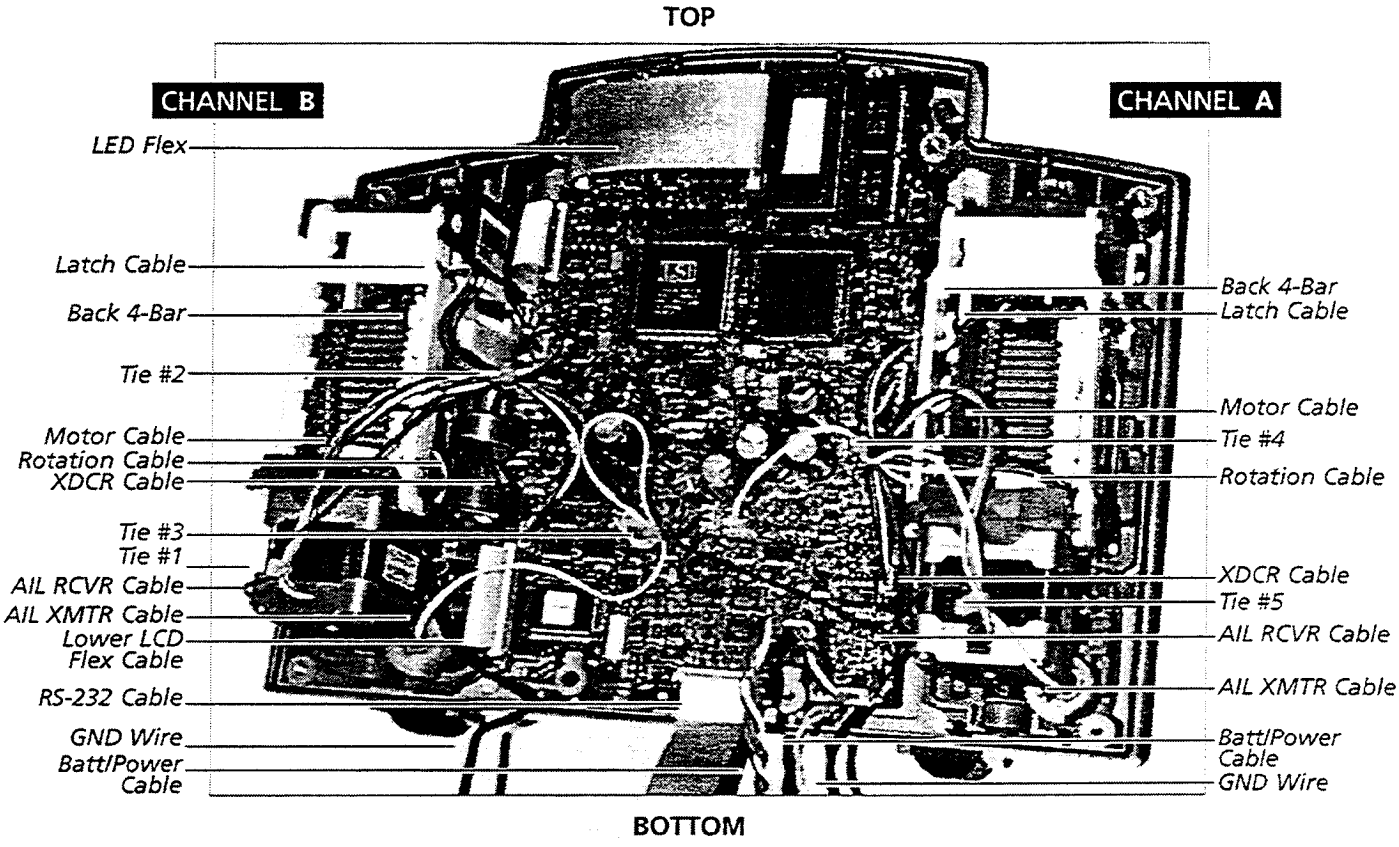
7. **To replace the Heat Sink:** remove speed nuts inside the rear case using a 3/8" socket wrench.

   Remove the Heat Sink.



Disassembly of the rear case is now complete.

5.4.2 Disassembly Procedure for Cable Routing



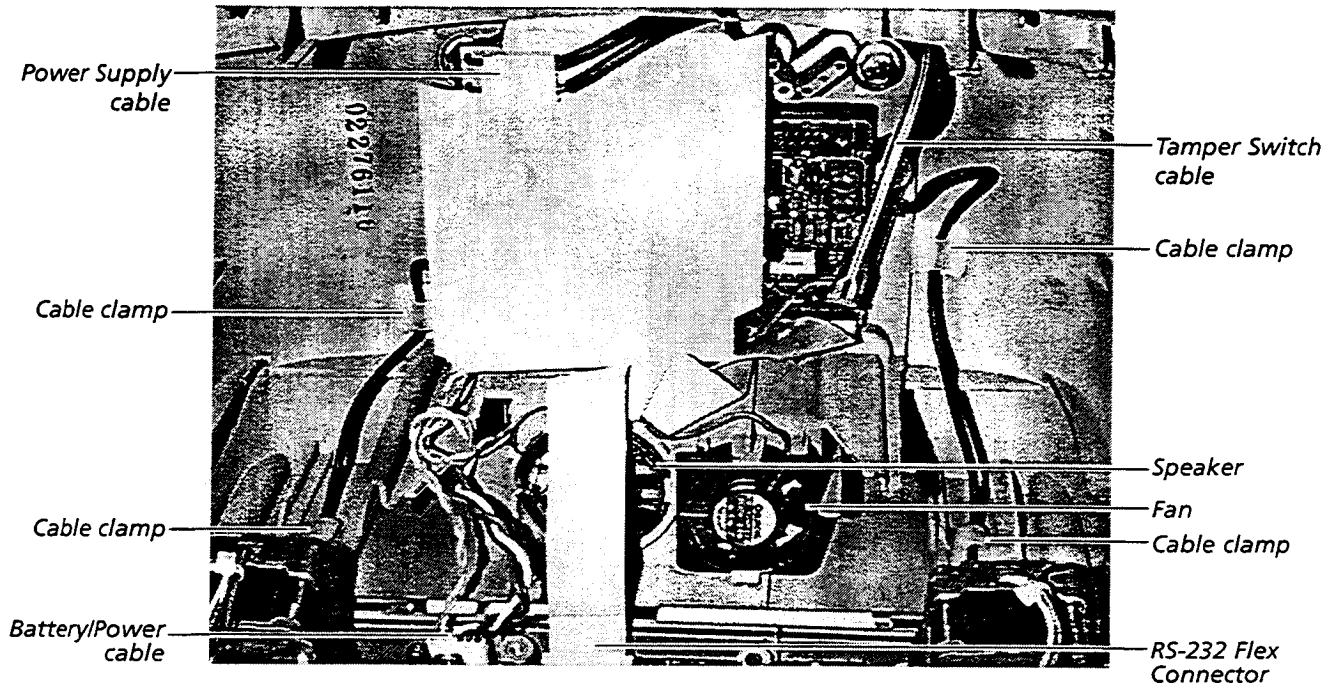
Pay close attention to cable routing when disassembling the instrument. The cables are specifically routed to ensure they are not pinched or stressed when reassembled. Channel A (ChA) and Channel B (ChB) wires are routed in the opposite direction to connect to the board assembly.

NOTE: Single channel pump routing is similar to Channel B (ChB).

A. Front Case:

NOTE: Exercise caution when removing connectors. Pulling on wires can break them. Wires and connectors must be replaced as part of an assembly. They cannot be repaired separately.

1. Cut tie #1for ChB motor and AIL receiver (black).
2. Cut tie #2 for ChB motor, Latch, Rotation and AIL receiver (black).
3. Cut tie #3 for ChB AIL transmitter (white) and ChA AIL transmitter (black).
4. Cut tie #4 for ChA motor, Latch, Rotation and AIL receiver (white).
5. Cut tie #5 for ChA motor and AIL receiver (white).
6. Disconnect ChA and ChB transducer wires (blue) from the board.
7. Disconnect ChA and ChB ground wires (black) going to the mechanism assembly.
8. Disconnect flex cables for front panel, LED modules, main LCD, RS-232 board assembly and lower LCD as needed. Lift up on locking bar before attempting to remove flex cable.
9. Continue disassembly as required.



B. Rear Case

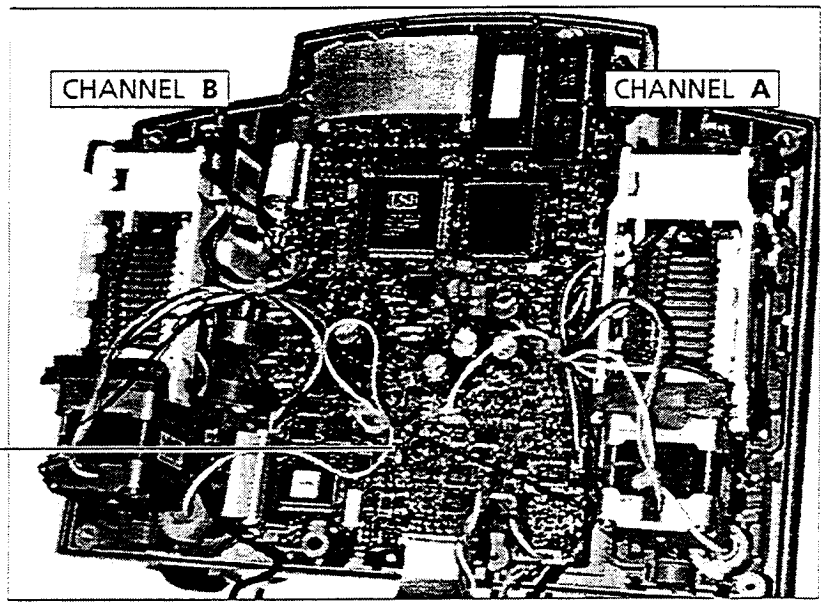
1. Disconnect flex cable for RS-232 board assembly. Lift up on locking bar before attempting to remove flex cable from main board assembly.
2. Disconnect power supply cable from power supply board.
3. Disconnect fan and speaker cable.
4. Disconnect battery/power cable from main board.
5. Disconnect ground wires from mechanism assembly. If needed, unhook ground wires from cable clamps (4 places on dual channel, 2 places on single channel).
6. Continue disassembly as required.

5.4.3 Disassembly of Front Case

1. Disconnect all wire connections to the Main PCB.

NOTE: When removing flex cables, carefully lift locking bar to remove cable from connector.

NOTE: Pay particular attention to wire routing. Wires should be routed back to initial scheme and similar to the example shown. This will prevent them from getting pinched and jamming the mechanism.



2. **To replace the main PCB on 710X/720X:** remove screw from Main PCB using Phillips screw driver. Slide Main PCB to top, then lift and remove.

NOTE: The large capacitor for the backup speaker may be discharged after removing the board. Jumper across terminals of capacitor C-146 (C-179) for one minute. See Troubleshooting Section for more information.

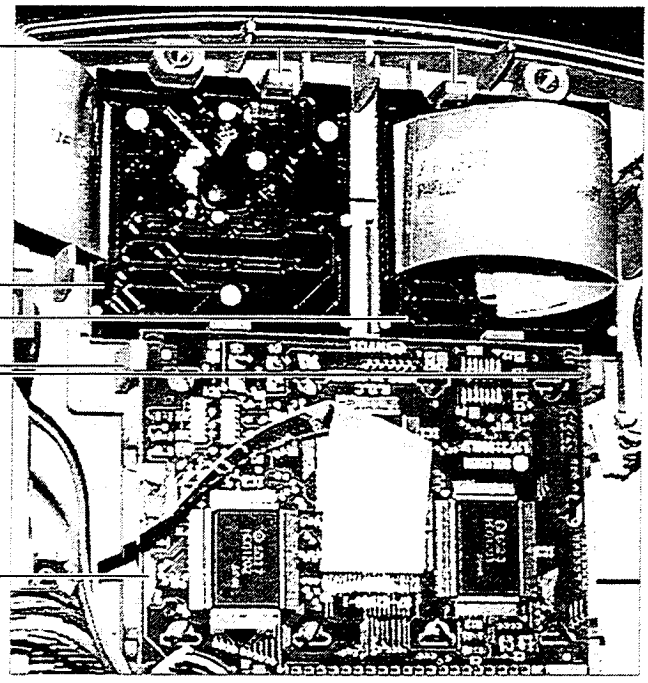
After installing the new Main PCB , perform the following:

a. Check Tc in Diagnostic Mode. D6 screen should have selected Tc=0.0. *See Chapter 6 for procedure to change, if needed for software 2.02 and higher.*

b. Check Rate Cal number in Diagnostic Mode. D4 screen should have a Rate Cal # of 182 to 214 *(See Chapter 5 for Rate Calibration Procedure, if needed). (See Chapter 6 for procedure to change)*

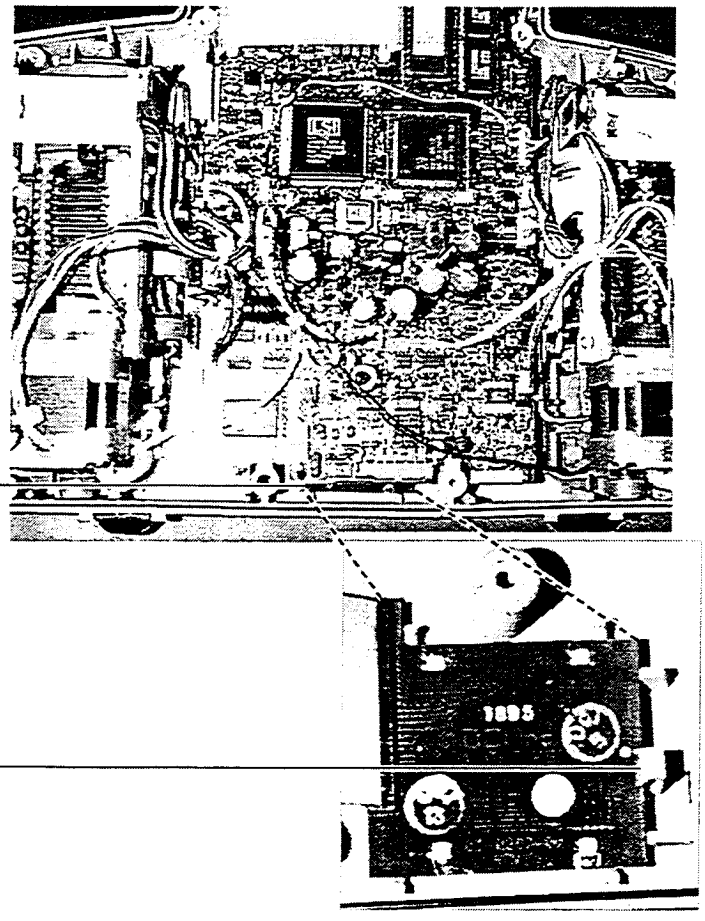
c. Perform Soft Pressure Calibration after one hour warm-up.

3. **To replace the LED modules:** Lift up on locking bar for flex cable and disconnect. Use fingers to push back snap fittings holding the upper LEDs (only one on single channel), then lift and remove.

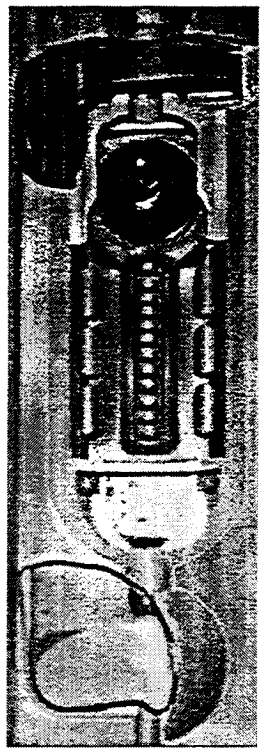


4. **To replace the Main LCD module:** Lift up on locking bar for flex cable and disconnect. Use fingers to push back snap fittings holding the Main LCD module, then lift and remove.

5. **To replace the lower LCD module:** Lift up on locking bar for flex cable and disconnect. Use fingers to push back snap fittings holding the lower LCD module, then lift and remove.



6. To replace the mechanism:



a. First, separate the front and rear case halves following the procedure in Section 5.4, "Disassembling Pump".

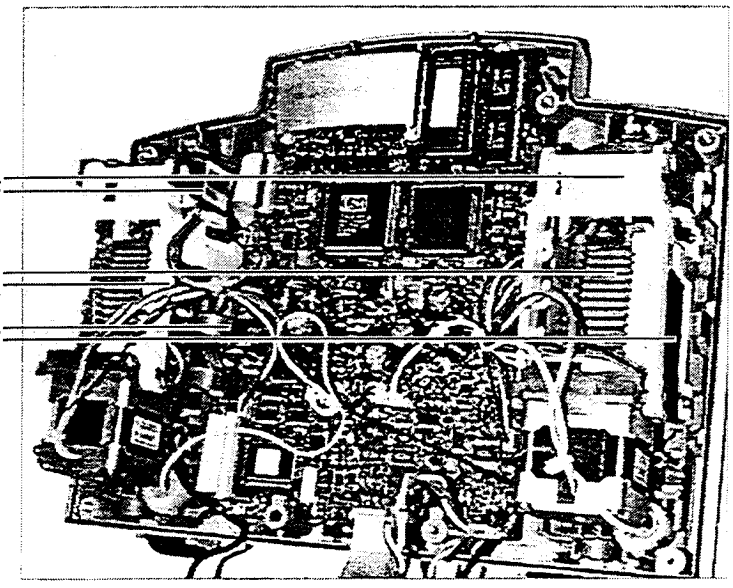
NOTE: Pay close attention to cable routing when disassembling the instrument. The cables are specifically routed to ensure they are not pinched or stressed when reassembled.

b. Move mechanism latch to the middle position. This will allow the air-in-line sensor to clear the case when extracted.

c. Disconnect wiring harnesses from the Main PCB. Note their location. They will be reconnected to the same location later in the procedure.

d. Using a flat head screw driver, unsnap the three snap fittings (top and both sides) holding the mechanism to the front case, then remove the pumping mechanism.

e. Mark the mechanism(s) latch housing "A" or "B" with permanent ink to ensure reinstallation in the proper location on dual channel pumps.



CAUTION: *Do not mix mechanisms in dual channel or with other instruments. When a mechanism is removed, it must go back in the original position or the pump will need hard and soft pressure calibration, as well as rate calibration.*

f. Install the mechanism.

g. Perform pressure and rate calibration (see chapters 5 and 6).

7. **To replace the key pad assembly:** remove the Key Pad only if it is defective. Removing a good Key Pad will ruin it.

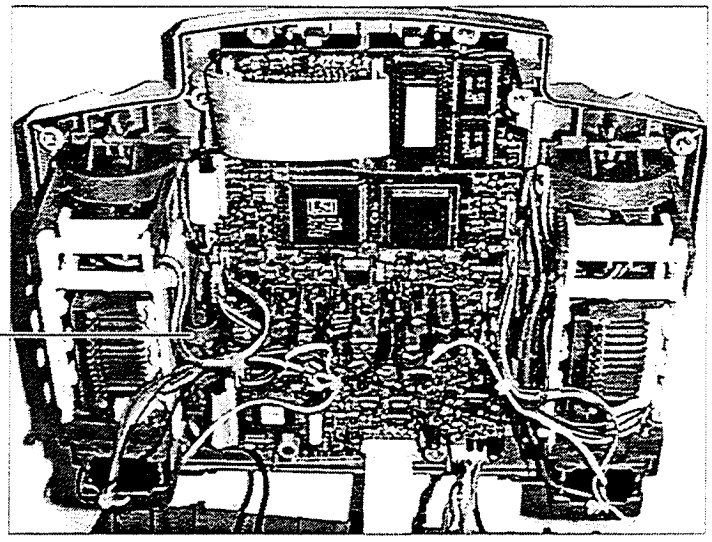
NOTE: Keypad pictures are for reference only and may not match your instrument.

a. First, separate the front and rear case halves following the disassembly instructions in Section 5.4 "Disassembling Pump".

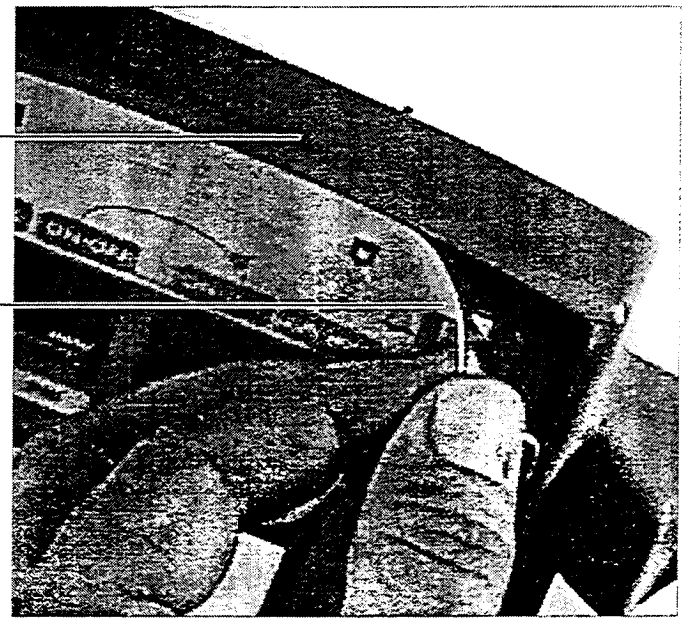
b. Disconnect power supply board connector/ battery cable and RS-232 flex cable from front case.

The rear case is now completely separated from the front case. Set it aside.

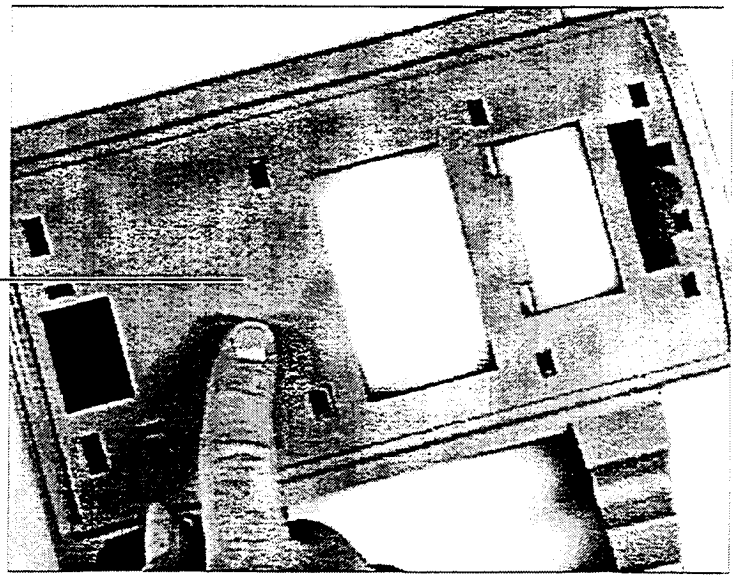
c. Disconnect the Key Pad Assembly flex cables from the Main PCB.



d. The Key Pad Assembly is removed by peeling it off the front case. Take a corner of the Key Pad and peel it away from the front case.

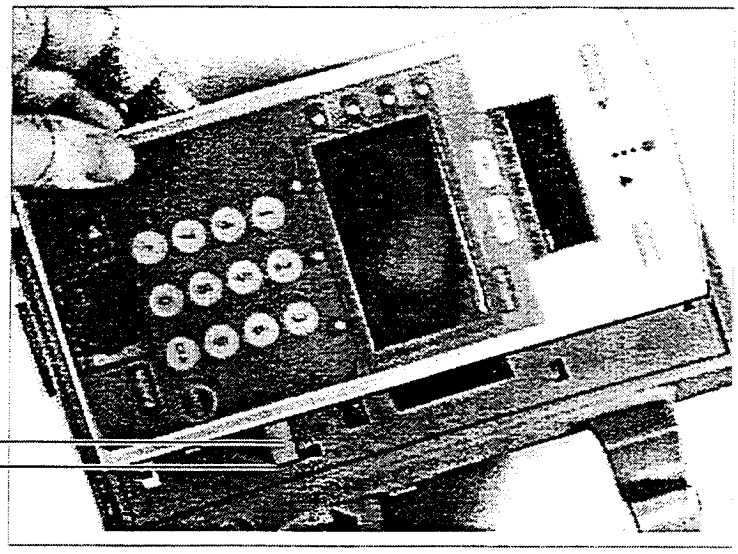


e. Adhesive will remain on the surface of the front case. Remove any remaining residue from surface before applying new Key Pad.



Alcohol may be used to remove adhesive residue.

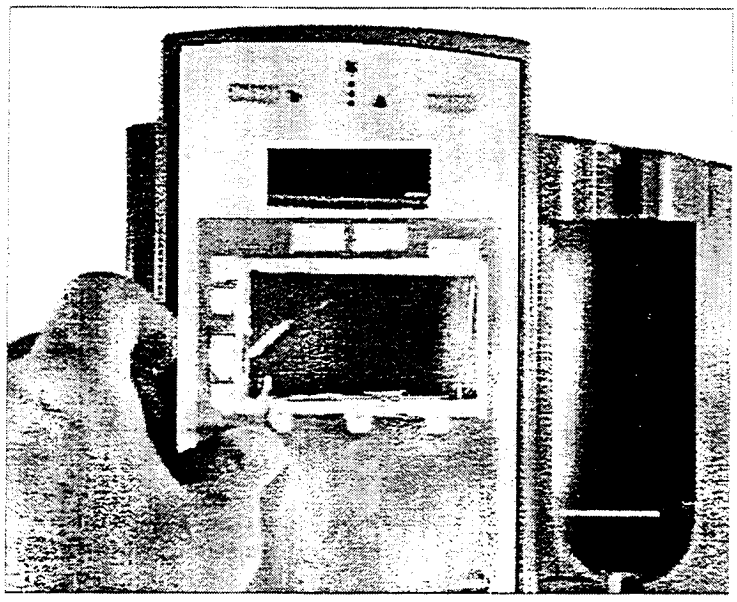
f. Position the front case so that it faces you. Fold back a small portion of the protective backing along the right side of the Key Pad. Insert the Key Pad Assembly flex cables into the slot and guide them through.



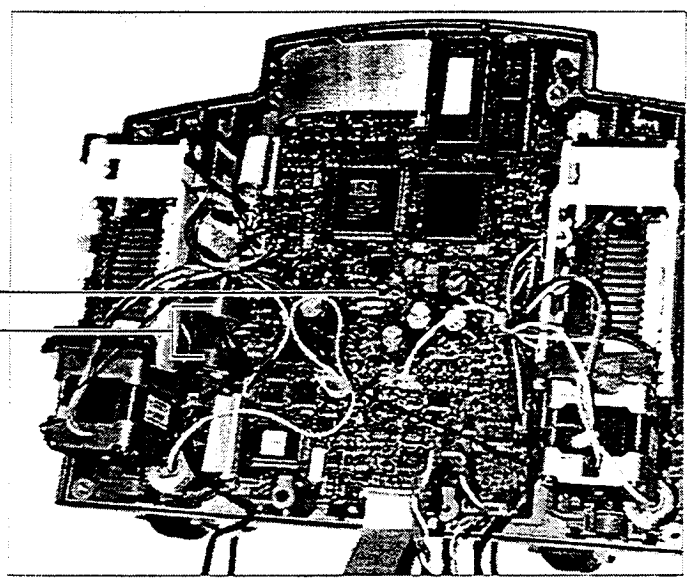
Key Pad Assembly flex cable

Slot

g. Align the right edge of the Key Pad Assembly and affix. If aligned, proceed to remove the remaining protective backing as you lay it into place. With your fingers, press around the perimeter of the Key Pad Assembly to assure adhesion to the front case and prevention of fluid ingress.



h. It may be necessary to loosen the Main PCB to gain access to the flex cables from inside the front case. To do so, remove screw from Main PCB using Phillips screw driver. Lift and move the Main PCB to the side to gain access to the flex cables.



Pull the flex cables through and to the side of the Main PCB. Reattach the Main PCB to the front case. Connect the flex cables to the Main PCB.

i. Reconnect power supply board connector/battery cable, and RS-232 flex cable from front case.

j. Reassemble both case halves following the instructions in Section 5.4 " Disassembling Pump", but in reverse sequence. See section 5.4.4 on cable routing before closing the pump.

k. Remove any protective covering from the front of the Key Pad Assembly.

l. Turn on the instrument, verify that the instrument beeps and that all display segments flash. This confirms that the pump has performed its self-tests, and is operating correctly. The instrument configuration values remain that same as those before power was disconnected. It is not necessary to reconfigure the instrument.

m. Test the switches. Refer to Section 6.4.15 "Testing Switches" to confirm that each switch is functional.

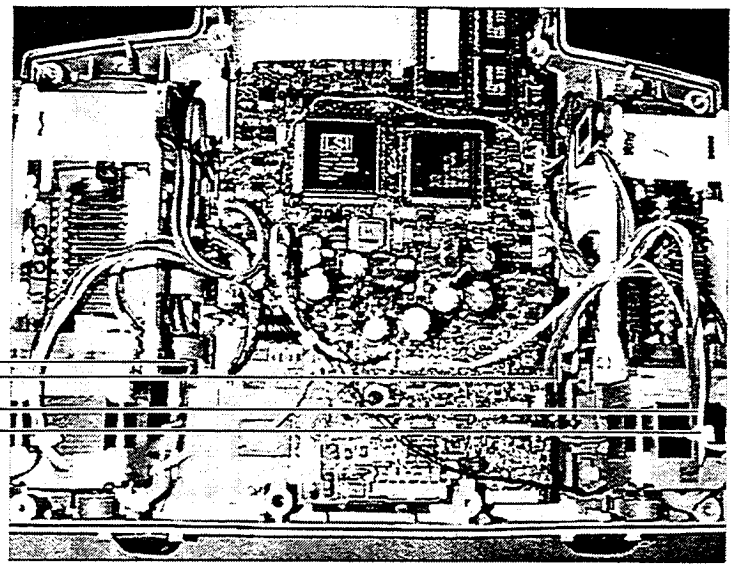
The replacement of the Key Pad assembly is complete.

5.4.4 Reassembly Procedure for Cable Routing

NOTE: Cable routing may change over time to ensure wires are not pinched and ease of assembly and disassembly is maintained. When the pump was opened, if the cable routing was different, follow that cable routing scheme.

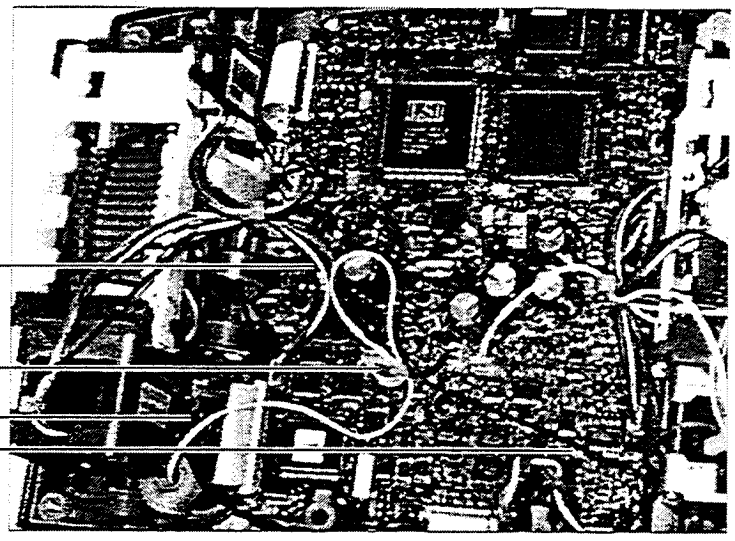
1. Ensure Main PCB Board and mechanism are installed in pump. Route ground wires through cable clamps, if present, and connect to the transducer.

2. Route transducer cable (blue) under motor assembly out left side for CH A (dual) and out right side for CH B (single). Bend wire up and lay along mechanism frame. Connect to the main board.



3. Route channel A air-in-line transmitter wire (white) up over motor and install tie wrap #5 with motor wires for CH A. Connect to main board assembly.

4. Route CH A ail receiver cable (black) out to left side of mechanism. Route CH B ail transmitter cable (white) to the right of mechanism. Connect both to main board. Install tie # 3 around both cables. Ensure CH B ail transmitter cable (white) and CH A ail receiver cable (black) has loop as shown.

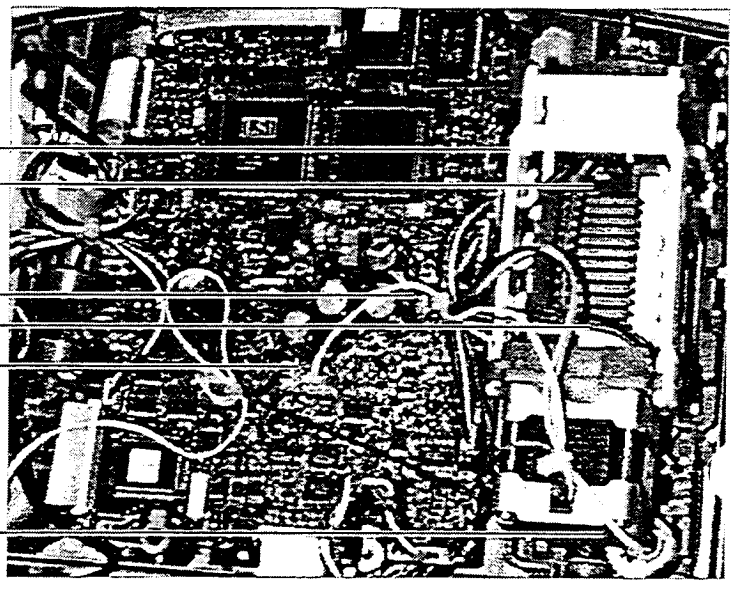


5. Route CH A rotation sensor cable out to right side and over back 4-bar (mechanism). Connect to main board.

6. Route CH A latch sensor to left under back 4-bar. Connect to main board.

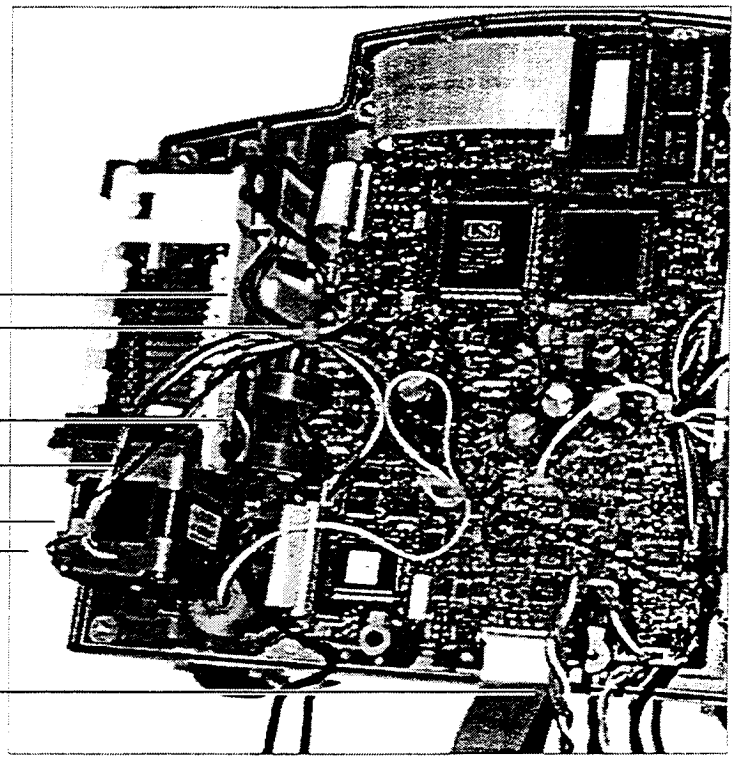
7. Connect CH A motor assembly cable to main board.

8. Install tie #4 around CH A motor, latch, rotation and ail transmitter (white) wires.



9. Route CH B ail receiver cable (black) up over motor assembly and connect to main board. Install tie # 1 to motor cable and CH B ail receiver cable (black).
10. Route CH B rotation sensor cable out to right side and under back 4-bar (mechanism). Connect to main board.
11. Route CH B latch sensor to right under back 4-bar. Connect to main board.
12. Install tie # 2 around CH B motor, latch, rotation and ail receiver cable (black) wires.
13. Ensure locking bars are up on flex cable connectors. Install flex cables for front panel, led modules, main lcd, RS-232 board assembly and lower lcd as needed to main board.
14. Install battery/power cable to main board.

WARNING: *Always perform a rate accuracy verification after mechanism and board have been removed and reinstalled or cables have been disconnected and reconnected.*



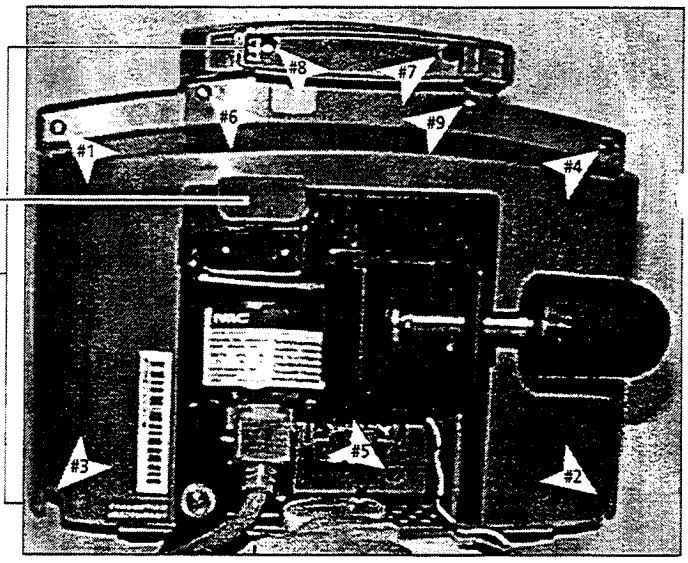
5.5 Assembling Pump

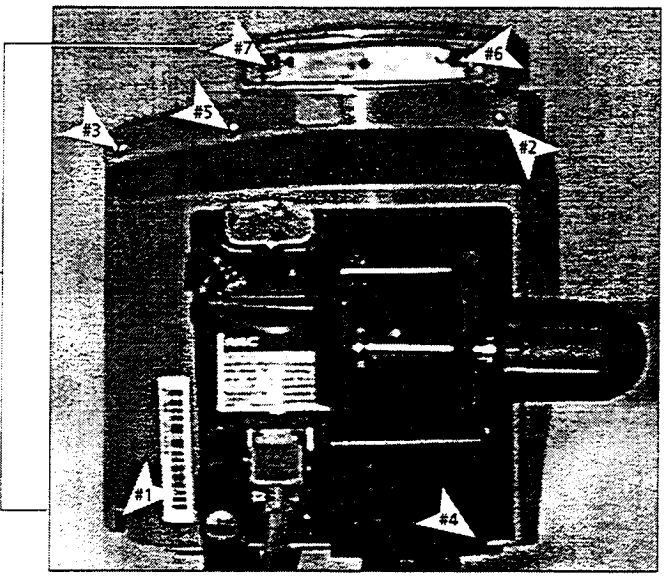
NOTE: Calibration coefficients for the transducer are stored in the EEPROM on the main board assembly. Once they have been calibrated, the Signature Edition mechanism and board assemblies become a matched set. Replacement of either requires pressure and rate calibration.

Assemble the pump in the reverse sequence of the disassembly instructions and section 5.4.4 on cable routing before closing the pump.

When reassembling the case halves, install and tighten the case mounting screws as follows:

1. Install and snug each screw, beginning with the #1 screw and following the sequence in figure, until all screws are snug and case halves are flush.
2. Tighten each screw a 1/4 turn more beginning with the #1 screw installed and following the sequence shown.
3. Close latch when assembly is complete.
4. If ECD feature is not being used, install rubber plug in flow sensor receptacle.





5.6 Test and Calibration

Additional testing and calibration may be required after certain repairs are completed. These tests are in addition to the Preventive Maintenance tests. See Table 5-3, "Level of Testing Guidelines" for more information.

5.6.1 Power-On Self Test

The power-on self test deals with determining the proper operating condition of the fully assembled pump. The pump contains extensive self-testing software. The self test is a final test.

The self test is initiated each time the instrument is turned on. The instrument continually tests itself during operation of the pump, as well. An alarm or error message will appear if there is a problem.

When turning on the instrument, verify that the instrument beeps and that all display segments and LEDs flash. This confirms that the pump has performed its self tests, and is operating correctly.

5.6.2 Mechanism Visual Check

Before the mechanism is placed back into the front case, visually check its functionality.

a. Ensure that all 12 followers are in place and mechanism is flush to front case.

b. Rotate the latch handle and check for full, uninterrupted range of motion.

c. Ensure that the seal is correctly in place and springs are not loose or damaged.

The mechanism will be further tested, when the pump is reassembled, during the self test, rate verification, and functional tests.

5.6.3 Mechanical Leak Test

1. Use a variable pressure air source (squeeze ball or equivalent), reservoir, and pressure gauge with setup as shown in Figure 5-2 " Leak Test Setup ". Install non-check valve set (e.g. 72013) into instrument.

NOTE: No fluid in set for mechanical leak test.

2. Cut off the drip chamber of the set, if needed, to place into a fluid container filled with water.
3. Install set in the pump and close the latch.
4. Connect variable pressure air source, reservoir, and pressure meter to set at bottom of instrument.
5. Apply pressure of 15 psi +1 psi (775 mmHg +50 mmHg) for one minute.
6. Verify air bubbles do not continue to show up in the fluid container.

NOTE: When air pressure is first applied a few bubbles are acceptable during mechanical leak test.

7. If bubbles continue to show in the fluid container, return instrument to factory or replace mechanism or case as needed.

5.6.4 Pressure Verification and Calibration Test

Refer to Chapter 6 "Calibrating Channel Pressure" for soft cal procedure.

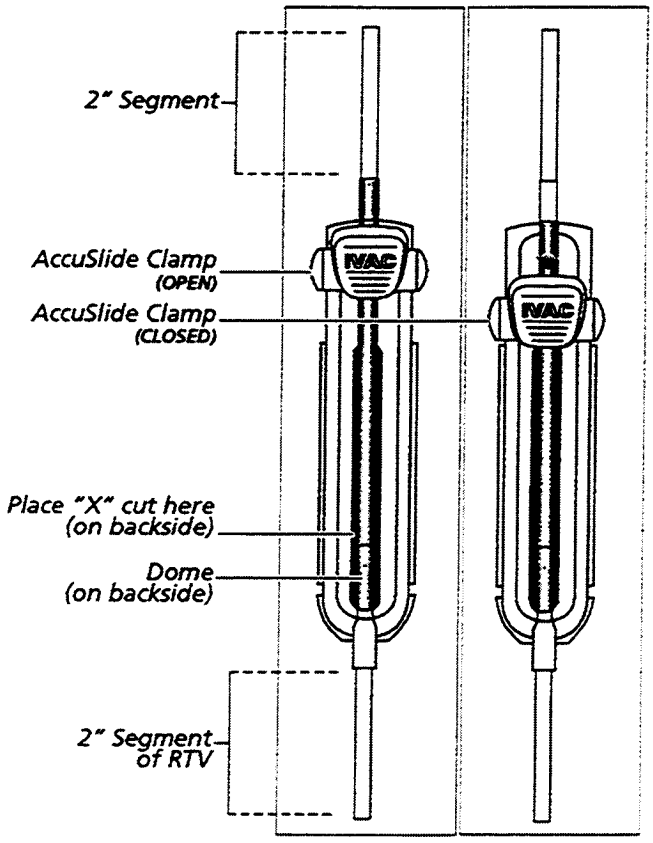
5.6.5 Set Sensor Check

1. Enter Diagnostic Mode and advance to page D6.
2. Install set and allow a 1 (one) hour warm up while in Diagnostic Mode.
3. The sensor reading with set in should be greater than 55/90 mmHg (auto-zero on/auto-zero off).
4. Remove set and close the latch. The sensor reading with set out should be -30 to +80 mmHg. If not, perform soft pressure calibration, Chapter 6.

5.6.6 Test Run Mode

The test run mode enables the instrument to run without fluid after being repaired. To run the instrument without fluid, perform the following:

1. Cut AccuSlide segment out of standard set. Leave 2 inches of tubing at the top and bottom.
2. Cut membrane on backside of AccuSlide clamp at bottom of pumping segment. Use knife or other appropriate tool and cut an 'X' into the membrane to relieve pressure that will build up during testing.
3. Move AccuSlide clamp up, to open position.
4. Fill lower portion of tubing with RTV. Do not let RTV enter the dome area.
5. Allow to dry (48 hours). Move AccuSlide clamp down until it "clicks" into the closed position, and install test set into the instrument.
6. Select rate and run for desired time period e.g. 100 ml/hr for 15 minutes.
7. Remove test set.



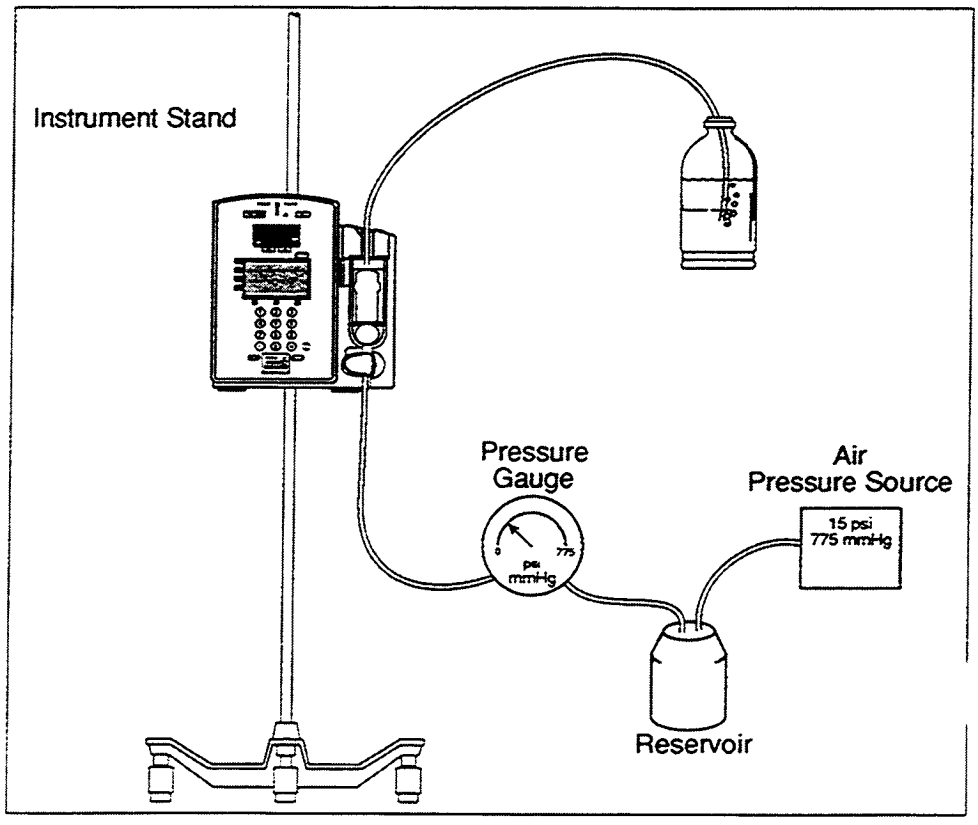


Figure 5-2 Leak Test Setup

5.6.7 Hard Pressure Cal Procedure

1. Ensure warmup of two hours minimum.
2. Leave unit on and connected to AC power and battery.
3. Follow procedure to disassemble instrument.

NOTE: There is one case screw inside battery compartment.

4. Do not disconnect any cables. Adjust pole clamp so that the knob is facing downward. Lay front case on desk/bench top.
5. Locate pot under motor and on backside of the transducer.
6. Evaluate the sensor in D6 screen (see Chapter 6) as follows:
   a. **Compensated** value is between 1000 and 1200, go to Pressure Cal screen. Verify sensor reading is between -30 and +80 mmHgS after set is removed (repeat for other channel if necessary). If not, perform soft pressure calibration.
   b. **Compensated** value is less than 1000, or more than 1200 then perform hard cal for this channel.
   c. D6 Screen Values:

1st Value	*2nd Value*	*3rd Value*	*4th Value*
VBRIDGE AT LAST CAL	*CURRENT VBRIDGE*	*UNCOMP SENSOR VALUE ADC COUNTS*	*(COMPENSATED) SENSOR VALUE ADC COUNTS*

7. Adjust transducer pot for a compensated value of 1100 ±25 counts while in the D6 screen and watching the compensated sensor value.
8. Once transducer is adjusted for proper reading, press OK to accept the value.
9. Apply the tamper seal (Metron Marker or equivalent) to the transducer.

NOTE: Care should be taken to avoid applying too much tamper seal so it does not effect the transducer.

10. Close unit by setting bottom of rear case onto front case using the case bosses for alignment. For a dual channel instrument, route the long ground wire into the corner of the case boss. Ensure that ground wires do not rub against mechanism.
11. Place rear case onto front case while watching all the cables for proper routing.
12. Close case by following pattern and tightening procedure outlined in Section 5.5.
13. Wait one hour for transducer to warmup again and check that compensated value is still in range as noted earlier.
14. Perform soft pressure cal procedure (after 1 hour warmup) as follows:
   a. Install 70ISS Press Cal Set.
   b. Advance to the D6 screen in the diagnostics mode. Select Cal Pressure for channel desired.
   c. Press soft key next to "0 mmHg", verify says pass to right and fail for "500 mmHg" and "Complete Press Cal" replaces sensor reading.
   d. Attach pressure meter and squeezed ball to end of pressure cal set. Apply 500 mmHg ± 1 mmHg.
   e. Press soft key next to "500 mmHg". Verify that both 0 and 500 values now say pass.
   f. Press ok to accept. Soft cal is now complete.

5.6.8 Checking Pressure Calibration Set

1. Go to the diagnostics mode, D6 screen, to access the Pressure Calibration section.
2. Note the sensor reading.
3. Install the pressure calibration set.
4. If the sensor reading has had a greater than ±20 count shift, or the pressure calibration set leaks, replace the set.

5.6.9 Rate Calibration Procedure

Provides Biomedical Technicians a procedure for optimizing the rate calibration value for each mechanism.

The rate calibration value controls the rate at which the motor turns, to help control the infusion rate. This procedure allows the rate calibration value to be set for each mechanism, using a rate calibration set, to enable optimization of the rate accuracy characteristics, for Models 7100E/7200E, 7100F/7200F, 7100G/7200G, 7101A/7201A and later versions.

a. Perform the test with the instrument set to the **Pressure Mode** (default).

b. Use and IVAC Rate Calibration Set, P/N 70RCS.

c. Run pump as per rate verification procedure (chapter 3).

d. If the rate accuracy does not fall within the required range of the 40 ml±5% (38 to 42 ml), and the test results were:

- outside a range of -5.5% to +7% (less than 37.8 ml, or greater than 42.8 ml)
  Return the instrument to IVAC Medical Systems for repair or replace the mechanism.
- inside a range of -5.5% to +7% (37.8 to 42.8 ml)
  Calculate and set a new rate calibration value, and perform the Rate Accuracy Verification Test.

1. View the Rate Calibration Information.

a. Enter the Diagnostics Mode.

b. Advance to page D4.

c. Single channel instrument: Press the soft key next to Cal Rate.
Dual channel instrument: Press the soft key next to Cal A Rate (for channel A), or Cal B Rate (for channel B).

d. Make a note of the current rate cal number(s), and the applicable channel if a dual channel instrument.

2. Calculate a new rate calibration value, as follows

Current rate Cal # = R
Percent of error = E
(use number only, not % or as a percentage)
Calculated cal number = A
New final cal number = N

NOTE: If, as a result of the following calculation, the new rate cal value falls outside the range of 182 to 214, return the instrument to ALARIS Medical Systems or replace the mechanism.

a. If the rate error is positive; i.e., above 40 ml, use the following formula:
Step 1: R + (E x 2) = A
Step 2: A + 2 = N
N is the number to enter into the rate cal screen (step 3d) for the applicable mechanism and channel, as selected in the Diagnostics Mode (step 1c).

b. If the rate error is negative; i.e., below 40 ml, use the following formula:
Step 1: R - (E x 2) = A
Step 2: A + 2 = N
N is the number to enter into the rate cal screen (step 3d) for the applicable mechanism and channel, as selected in the Diagnostics Mode (step 1c).

3. Reset the rate calibration value (The instrument should be in the Rate Cal section of the Diagnostics Mode, as in step 1.)

a. Dual channel instrument: Ensure that the applicable channel is selected (see step 1c).

b. Press the upper left soft key twice. The instrument will beep each time the key is pressed, but the display will not change.

c. Press the soft key next to Cal # to highlight the cal number.

d. Enter the new rate calibration value ("N": calculated in step 2) on the key pad.

e. Press enter.

f. Press OK.

4. Perform the Rate Accuracy Verification Test as specified in Chapter 3, with the following differences:

a. Perform the test with the instrument set to the Pressure mode (default).

b. Use an IVAC Rate Calibration Set, P/N 70RCS.

c. If the rate accuracy falls outside a 40 ml ±4% range (less than 38.4 ml, or greater than 41.6 ml), return the instrument to ALARIS Medical Systems for repair or replace the mechanism.

NOTE: The disposable set (70RCS) cannot be used for more than 40 rate accuracy verification runs (20 rate cal number changes).

5.7 Level of Testing Guidelines

The following tests should be performed whenever the pump is updated, repaired, or checked out in response to anything that would impair the operation of the pump. For details, see Chapters 3 and 5.

NOTE: If unit operation is at all doubtful, perform a complete PM procedure. This table provides minimum test requirements.

Table 5-2 Level of Testing Guidelines

■ = *Perform test*
X = *Optional*

	Functional Test	Flow Stop Test	Rate Verification Test	Pressure Verification Test	Ground Current Resistance Test	Display Test	Leak Test (Mechanical)	Instrument Configuration	Clear Battery Hours	Set Sensor Check	Pressure Calibration (soft)	Pressure Calibration (hard)	Perform/Enter Rate Cal #	Enter Tc=0	Mechanism Visual Check	Test Run Mode
Battery Replaced									■							
Case Replaced	■	■	■	■	■		X			■					X	X
Keyboard Assy Replaced	■		■		■					X						
LED Module Replaced	■		■		■	■				X						
Lower LCD Module R/R	■		■		■	■				X						
Main Board Removed/Replaced	■		■	■	■			■		■	■	■	■	■		X
Main LCD Module R/R	■		■		■	■				X						
Mechanism Removed/Replaced	■	■	■		■		■			■	■	■	■		■	X
New Instrument Checkout	■	■	■	■	■			■		■						
No Fault Found	■		■							■						X
Panel Lock Replaced	■		■		■											
Power Switcher Replaced	X		■		■											
Rate Accuracy Failed After Rate Cal							■									
Speaker Replaced	■		■		■											
Software Update/replace	■		■	■	■			■			■		■	■		X
Unit Dropped	■	■	■	■	■	■	■			■					■	X
Other Repairs	■	X	■	■	■	■				■						X

Chapter 6 — TROUBLESHOOTING

WARNING: *Use extreme caution in servicing the instrument when connected to AC power. Hazardous voltages are present when AC power is connected regardless of the setting of the power switch.*

6.1 Introduction

This chapter contains descriptions of possible operating errors and technical problems that may be encountered during use of the pump. Refer to this chapter before attempting to repair, replace, or service any component or assembly.

To facilitate troubleshooting, the pump will alarm and display prompts that direct attention to the problem. Alarms that relate to operating problems are listed in the Directions for Use manual. Refer to Table 6-1 "Technical Troubleshooting Guide" for problems that may occur and require calibration or repair and Table 6-2 "Error Messages" for messages that indicate an internal malfunction. The Battery Manager error codes listed in Table 6-3 relate to codes displayed in the lower LCD. These error codes are not stored in memory.

Section 6.4 "Diagnostics Mode" contains directions for accessing various diagnostic modes. At the end of this chapter is a fold-out map of all the diagnostic screens.

NOTE: Steps listed are in order of actions to take to correct problem/fault.

NOTE: Record alarm history using the Alarm or History Error mode described in Section 6.4.3 "Viewing Alarm or Error History" before disconnecting the battery, disassembling, troubleshooting, or testing the pump.

6.2 Technical Troubleshooting Guide

Table 6-1 "Technical Troubleshooting Guide" contains information for troubleshooting possible technical problems.

Before making a final diagnosis, visually inspect the pump for damage. Pay particular attention to the power cord and plug. Verify that the instrument is electrically safe by checking:

- The ground wire resistance is 0.10 ohms or less.
- The ground current leakage is 100 mA or less.

NOTE: Mechanism and boards can only be replaced in 7100E/7200E (or later) instruments.

Table 6-1. Technical Troubleshooting Guide

Problem	Remedy
Accuracy Verification Fails	1. Try new 70RCS Rate Cal set and repeat test a second time. 2. Check for mechanical damage and proper loading of administration set. 3. Perform Rate Calibration. 4. Replace mechanism 5. Return to factory.
Air-in-line	1. Air in set, remove air or press RESET to move air through line. 2. Change AIL setting. 3. Clean AIL transducer/receiver. 4. Check connector. 5. Replace mechanism. 6. Return to factory.
Backup speaker activated while handling Main PCB	1. Discharge capacitor C-146 (*C-179*) by placing jumper across capacitor terminals.
Batt Refresh	A charge/discharge/recharge cycle was initiated. This can occur: 1. When the battery is disconnected and reconnected to AC power. 2. By entering 0.0AH in rated capacity, connecting to AC and then change rated capacity back to 1.3AH.
Battery Low Battery Depleted	1. Plug into AC power. 2. Recondition battery with 2 or 3 charge/discharge cycles. 3. Replace battery. 4. Replace Main PCB. 5. Return to factory.
Downstream Occlusion	1. Check setup and tubing (kinked, clogged filter, etc.). 2. Check pressure calibration.
Display Problem	1. Check cable connections. 2. Replace LCD/LED module. 3. Replace Main PCB. 4. Return to factory.
Fan is Noisy	1. Check cable routing and snap fits. 2. Replace fan. 3. Replace Main PCB. 4. Return to factory.
Hold/Setup Time Exceeded	1. Press Run/Hold to resume operation. 2. Turn off pump if not in use.
Intermittent Operation	1. Check cable connections to Main PCB. 2. Replace Main PCB. 3. Return to factory.
Instrument/ Channel Malfunction	1. Turn instrument/channel off and back on to see if problem clears. 2. Refer to alarm history for fault detected and Table 6-2
Key Stuck Alarm	1. Turn pump off and back on to see if problem clears. 2. Replace channel A LED Module. 3. Replace key pad assembly. 4. Replace Main PCB. 5. Return to factory.
Latch Open Alarm	1. Check for proper set installation. 2. Verify latch closed and moves easily back and forth. 3. Verify sensor not loose. 4. Verify connector not loose. 5. Replace mechanism. 6. Return to factory.
LCD Contrast is Dark or Light	1. Change contrast setting to 80, tilt unit to help view or follow information in Diagnostics Mode. 2. Replace Main LCD. 3. Replace Main PCB. 4. Return to factory.
Mechanical Leak Test Fails	1. Check mechanism for damage and proper mounting into snap fittings. 2. Replace mechanism. 3. Return to factory.

Table 6-1. Technical Troubleshooting Guide (cont.)

Problem	Remedy
No Power	1. Wait 15 seconds after connecting to AC power. 2. Check/replace battery. 3. Replace power supply board (AC off line switcher). 4. Replace key pad. 5. Replace Main PCB. 6. Return to factory.
Press Restart	In alarm history; this indicates the infusion reached occlusion point (12 psi ± 4) in pressure or resistance modes, but cleared within 40 seconds.
Pressure Calibration (Soft) Fails	1. Check setup and warmup time of at least one hour. 2. Retry with new 70ISS set. 3. Perform pressure calibration (hard). 4. Replace mechanism. 5. Replace Main PCB. 6. Return to factory.
Pressure Verification Fails	1. Check for damage and proper loading of 70ISS set. 2. Perform pressure calibration (soft). 3. Perform pressure calibration (hard). 4. Replace mechanism. 5. Return to factory.
Program Lost	Normal condition if battery disconnected or in a low state of charge. Reprogram settings and continue operation.
Resis Restart	In alarm history; this indicates the infusion reached 100% resistance or alarm point, but cleared within 40 seconds.
Self Check Due	1. Install set, wait one minute and remove set. 2. Check latch sensor for proper operation. 3. Check pressure calibration (soft). 4. Perform Hard Pressure Cal 5. Replace mechanism. 6. Return to factory.
Set Out Alarms	1. Try another set. 2. Lower instrument closer to patient level. 3. Perform pressure calibration (soft). 4. Perform pressure calibration (hard). 5. Replace mechanism. 6. Return to factory.
Set Sensor Check Fails	1. Try a second set. 2. Perform pressure verification.
SW APPL	Software error. Turn instrument off and back on. If problem reoccurs, return instrument to factory or replace Main PCB.
SW Shutdown	Battery voltage reached 10.2 volts, or five minutes elapsed since low battery alarm, and the battery manager told the CPU to turn off the instrument. Charge, or replace battery, as needed.
Switches Inoperative	1. Replace (Channel A) Led Module. 2. Replace keypad. 3. Replace Main PCB. 4. Return to factory.
Upstream Occlusion Alarm	1. Try another set. 2. Raise container higher to patient. 3. Check for downstream occlusion. 4. Check pressure cal (soft). 5. Could be high resistance in catheter, positional IV, etc.
USO Restart	In alarm history; this indicates a resistance condition existed making it difficult to distinguish between upstream and downstream occlusion, but cleared in a few seconds.

6.3 Error Messages

The following hardware error messages can be generated by the instrument. These display messages indicate that the instrument has detected an internal malfunction. The battery manager error codes in Use these tables to diagnose and correct technical problems.

Table 6-2. Error Messages

Message	Probable Cause	Remedy
AIL DETECTOR	Air-in-line detector failed. Broken wire or loose connection.	1. Clean. 2. Test in diagnostic mode. 3. Replace mechanism. 4. Return to factory.
BATTERY OPEN	Battery Manager reported battery open.	1. Check connector. 2. Replace battery. 3. Replace Main PCB. 4. Return to factory.
BATTERY SHORT	Battery Manager reported battery shorted.	1. Check connector. 2. Replace battery. 3. Replace Main PCB. 4. Return to factory.
BK SPKR CONECT	Backup speaker power didn't connect. (Start-up)	1. Replace Main PCB. 2. Return to factory.
BK SPKR DISCON	Backup speaker power didn't disconnect. (Start-up)	1. Replace Main PCB. 2. Return to factory.
BKUP SPKR ERR	Backup speaker didn't operate. (Start-up and run)	1. Replace Main PCB. 2. Return to factory.
CLOCK SYNC ERR	Main CPU and watch dog clocks do not agree.	1. Replace Main PCB. 2. Return to factory.
CPU TEST FAIL	CPU test failed. (Start-up and run)	1. Replace Main PCB. 2. Return to factory.
ECD UNINSTALLED	Fault in flow sensor interface.	1. Check ECD Board and connections. 2. Replace Main PCB. 3. Return to factory.
EEPROM BAD CRC	Unrecoverable EEPROM CRC error.	1. Replace Main PCB. 2. Return to factory.
EPROM CRC	CRC generator output did not equal CRC value in ROM.	1. Replace EPROM. 2. Replace Main PCB. 3. Return to factory.
HW CRC GEN	CRC generator did not return zero after last byte.	1. Replace Main PCB. 2. Return to factory.
HW MALFUNCTION	Battery Manager reported hardware malfunction.	1. Replace Main PCB. 2. Return to factory.
ILLEGAL RESET	Processor reset while running.	1. Replace Main PCB. 2. Return to factory.
LATCH ERR	Latch sensor failed.	1. Check placement/connector. 2. Replace mechanism. 3. Return to factory.
LCD RAM ERROR	LCD controller memory didn't match image in main RAM.	1. Replace LCD module. 2. Replace Main PCB. 3. Return to factory.

Table 6-2. Error Messages (cont.)

Message	Probable Cause	Remedy
LCD TURNED OFF	LCD Controller is off.	1. Replace LCD module. 2. Replace Main PCB. 3. Return to factory.
LED CH TEST	LED error. (Start-up)	1. Replace LED module. 2. Replace Main PCB. 3. Return to factory.
LED SEG CHAN	LED stuck row detect failure. (Start-up) Stuck row. (Start-up or run) Segment failure. (Start-up or run)	1. Replace LED module. 2. Replace Main PCB. 3. Return to factory.
LED SEG INST	LED stuck row detect failure. (Start-up) Stuck row. (Start-up or run) Segment failure. (Start-up or run)	1. Replace LED module. 2. Replace Main PCB. 3. Return to factory.
MOTOR BEHIND	Motor didn't step right number of steps.	1. Check Optics. 2. Replace mechanism. 3. Replace Main PCB. 4. Return to factory.
MOTOR MID	Motor too slow for fast bi-rate or too fast for slow bi-rate.	1. Check Optics. 2. Replace mechanism. 3. Replace Main PCB. 4. Return to factory.
MOTOR SYNC	Motor didn't step right number of steps.	1. Check Optics and connections. 2. Check motorscrews not loose. 3. Replace mechanism. 4. Replace Main PCB. 5. Return to factory.
MOTOR TOO FAST	Motor running too fast.	1. Check Optics. 2. Replace mechanism. 3. Replace Main PCB. 4. Return to factory.
MOTOR TOO SLOW	Motor running too slow or not running.	1. Check Optics. 2. Replace mechanism. 3. Replace Main PCB. 4. Return to factory.
MTR CURR SENSE	Motor current sense failed.	1. Replace mechanism. 2. Replace Main PCB. 3. Return to factory.
PM BAD COMMAND	Battery manager or SCU error.	1. Reseat PM BD in socket. 2. Replace Main PCB. 3. Return to factory.
PM BAD CRC	Battery manager of SCU error.	1. Reseat PM BD in socket. 2. Replace Main PCB. 3. Return to factory.
PM ERROR	Battery manager error. (Start-up or shutdown)	1. Reseat PM BD in socket. 2. Replace Main PCB. 3. Return to factory.
PRESSURE CAL REQ	Pressure Calibration required.	1. Perform pressure cal (soft). 2. Perform pressure cal (hard). 3. Replace mechanism. 4. Replace Main PCB 5. Return to factory.

Table 6-2. Error Messages (cont.)

Message	Probable Cause	Remedy
PRESSURE ERR	Pressure sensor test (test pulse) failed.	1. Try another set. 2. Check for downstream occlusion. 3. Perform pressure cal (soft). 4. Perform pressure cal (hard). 5. Replace mechanism if TC=0 or 4095 (±5). 6. Return to factory.
PRI SPEAKER ERR	Primary audio failed.	1. Replace speaker and check connections. 2. Check flex cable to Main PCB connected. 3. Replace Main PCB. 4. Return to factory.
RAM ADDR BUS	Address bus test failed. (Start and run)	1. Replace Main PCB. 2. Return to factory.
RAM CLEARED	Recoverable RAM error. All data lost. Normal occurrence for manually initiated refresh cycle.	1. Turn power off and back on, should get program lost message, continue operation. 2. Replace Main PCB. 3. Replace LED module. 4. Return to factory.
RAM COMPARATOR	RAM comparator failed to detect a forced phantom RAM error. (Start-up and run)	1. Turn power OFF/ON to reset. 2. Replace Main PCB. 3. Return to factory.
RAM DATA BUS	RAM data test (dedicated byte) failed.(Start-up and run)	1. Replace Main PCB. 2. Return to factory.
RAM DMA WRITE	DMA write to RAM detected. (Start-up and run)	1. Replace Main PCB. 2. Return to factory.
RAM PHANTOM RD	Phantom RAM didn't compare equal. (Start-up and run)	1. Replace Main PCB. 2. Return to factory.
RAM TEST WHOLE	Unrecoverable phantom RAM compare error at start-up.	1. Replace Main PCB. 2. Return to factory.
RATE CAL REQ	Channel requires rate calibration.	1. Perform/Check rate cal. (#182 to 214) 2. Replace mechanism. 3. Replace Main PCB. 4. Return to factory.
SCU ERROR	Serial control unit error. (Start-up and shut-down)	1. Replace Main PCB. 2. Return to factory.
SENSOR RNG ERR	Pressure sensor failed during calibration.	1. Replace Main PCB. 2. Return to factory.
SPURIOUS INT	Spurious interrupt or bad jump.	1. Replace Main PCB. 2. Return to factory.
STUCK PWR KEY	Power key stuck or held down too long (over 6 sec.).	1. Replace keyboard and front panel assy. 2. Replace Main PCB. 3. Return to factory.
S/W SHUTDOWN.	Battery voltage less than 10.2V	1. Connect to AC Power. 2. Replace battery. 3. Replace Main PCB. 4. Return to factory.

Table 6-2. Error Messages (cont.)

Message	Probable Cause	Remedy
PERFORM TEMP CAL	Channel requires temperature calibration.	1. Check TC=0 in Diagnostic Mode for 7100E/7200E or later. 2. Replace Main PCB. 3. Replace mechanism. 4. Return to factory.
Vbackup HIGH	VBKUP HIGH over 6.5	1. Replace Main PCB. 2. Return to factory.
Vbackup LOW	VBKUP less than 4.85 V.	1. Replace Main PCB. 2. Return to factory.
VBRIDGE ERROR	Bridge voltage on pressure sensor incorrect.	1. Let instrument warm up for 1 hour. 2. Check for downstream occlusion. 3. Try another set. 4. Perform pressure cal (soft). 5. Perform pressure cal (hard). 6. Replace mechanism. 7. Return to factory.
Vcc HIGH	Vcc high. 5.469 Volts	1. Replace Main PCB. 2. Return to factory.
Vcc LOW	Vcc low. 4.632 Volts	1. Replace Main PCB. 2. Return to factory.
Vref HIGH	Vref high. 4.240 Volts	1. Replace Main PCB. 2. Return to factory.
Vref LOW	Vref low. 3.964 Volts	1. Replace Main PCB. 2. Return to factory.
WD ALARM	Watchdog has fired.	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.
WD EARLY ERROR	Watchdog didn't fire when stroked early.(Start-up)	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.
WD FORCE ERROR	Watchdog didn't fire when forced. (Start-up)	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.
WD LATE ERROR	Watchdog didn't fire when stroked late. (Start-up)	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.
WD MOTOR ON	Watchdog couldn't disable motor. (Start-up)	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.
WD MTR OFF ERROR	Watchdog could not disable motor. (Start-up)	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.
WD RESET OFF ERROR	Watchdog power-on test failed.	1. Reseat Power Manager Bd in socket. 2. Replace Main PCB. 3. Return to factory.

Table 6-3. Battery Manager Error Codes *(not in Alarm History)*

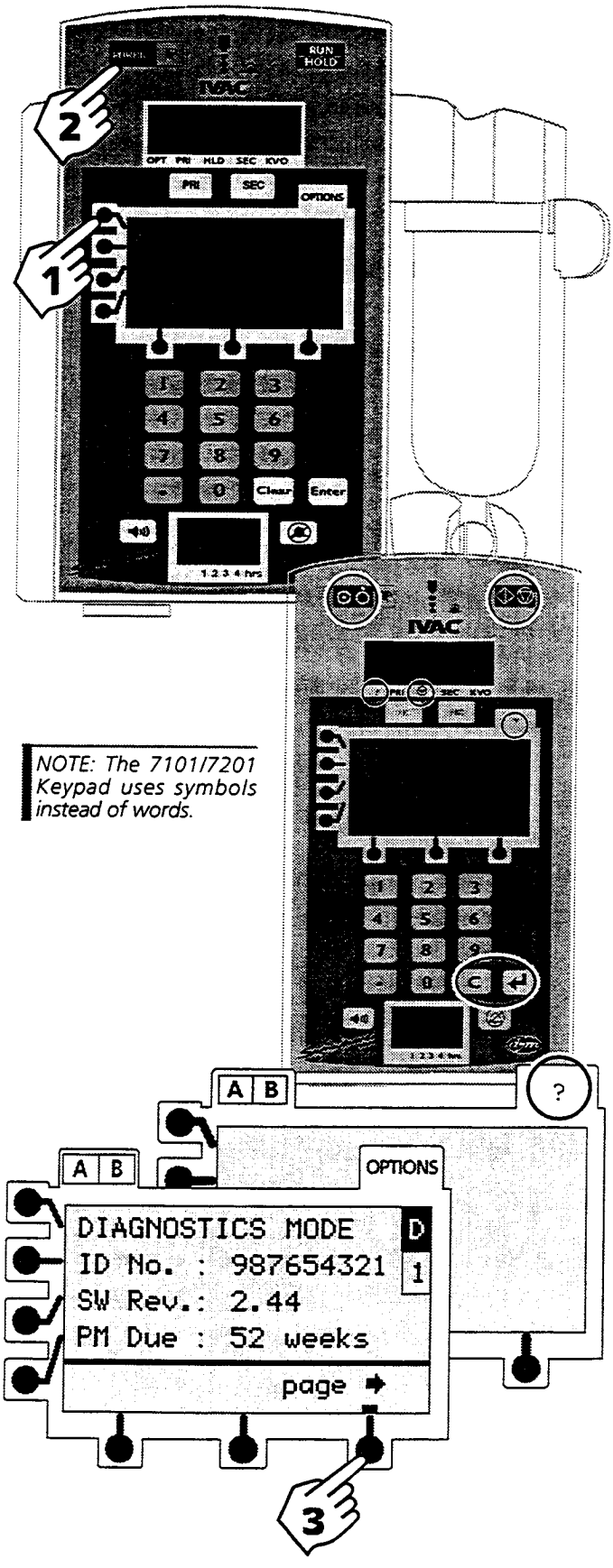
Message	Probable Cause	Remedy
ERR I - ROM CRC	Battery manager code failure.	1. Replace Main PCB. 2. Return to factory.
ERR 2 - RAM TEST	Battery manager code failure.	1. Replace Main PCB. 2. Return to factory.
ERR 3 - CPU	Battery manager code failure.	1. Replace Main PCB. 2. Return to factory.
ERR 4 - WATCHDOG ONE-SHOT TIMINGS	Watchdog circuit logic failure.	1. Replace Main PCB. 2. Return to factory.
ERR 5 - ON/OFF FLIP-FLOP WRONG STATE	Cannot set/clear flip-flop condition.	1. Replace Main PCB. 2. Return to factory.
ERR 6 - CURRENT INTEGRATOR	Battery current monitor circuit bad. or system has excess current draw.	1. Charge battery. 2. Replace battery. 3. Replace Main PCB. 4. Return to factory.
BATT	Battery temperature outside 0° - 60°C or battery voltage <10V or >18.8V.	1. Disconnect and reconnect battery to initiate a refresh cycle. Connect to AC. 2. Replace battery. 3. Replace Main PCB. 4. Return to factory.

6.4 Diagnostics Mode

The Diagnostic Mode allows a hospital to manage periodic preventive maintenance of the instrument and view the instrument's history. It allows testing of functions and entry of the instrument's ID number. For quick reference, a fold-out map of all diagnostic screens is located at the end of this module.

Pressing a soft key at the side of the main display the first time selects it for editing. Some features are edited by subsequent presses of the soft key to cycle through available options. Other features are edited by means of the numeric keyboard.

NOTE: Pressing **undo** *or* **cancel** *will undo any edits made to that page, and stay on the page. Pressing* **ok** *will accept all information on the page, and return to menu page.*



NOTE: The 7101/7201 Keypad uses symbols instead of words.

6.4.1 Entering Diagnostics Mode

The instrument must be off (both channels must be off for the Model 7200 Series instrument).

Though the figures in this procedure depict a single channel pump, the procedure for the dual channel pump is the same. Channel specific items will display "A" or "B" in upper left corner.

1. Press and hold the left-top display soft key.
2. Press and release POWER switch. Continue to press the display soft key until the Diagnostic Mode display appears, then release.
3. Page D1 of the Diagnostics Mode is displayed. This is a read only display. Press **page** ▶ to advance to the page you want to configure.

6.4.2 Setting Preventive Maintenance Interval

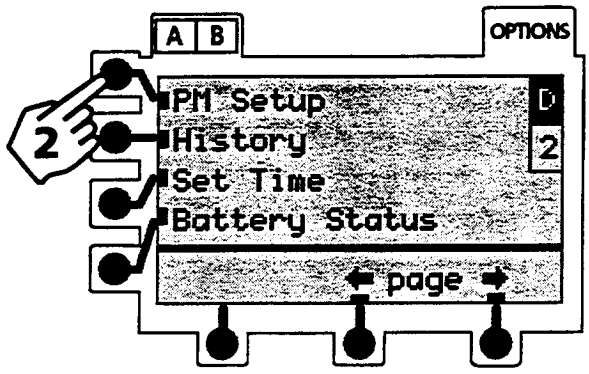
The preventive maintenance reminder is a message that appears upon start-up, telling the clinician that the maintenance cycle has elapsed. The clinician may choose to bypass the message and operate the pump as normal. The reminder will continue to appear at start-up until it is reset.

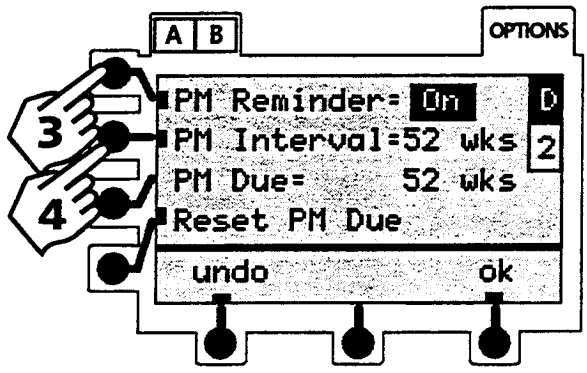
1. Advance to the D2 page (notice D2 in the upper right corner of the display).
2. Press the **PM Setup** soft key.
3. Press and release the **PM Reminder** soft key to cycle between On and Off.
4. Press the **PM Interval** soft key.
5. Use the numeric key pad to enter the desired maintenance interval (1 to 52 weeks). Press ENTER. Setting the PM Interval always resets the PM Due to the same value as the PM Interval.

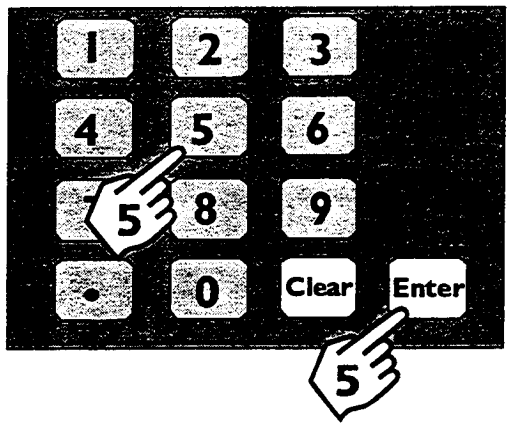
NOTE: PM Due decrements with calendar time and is displayed to the nearest week.

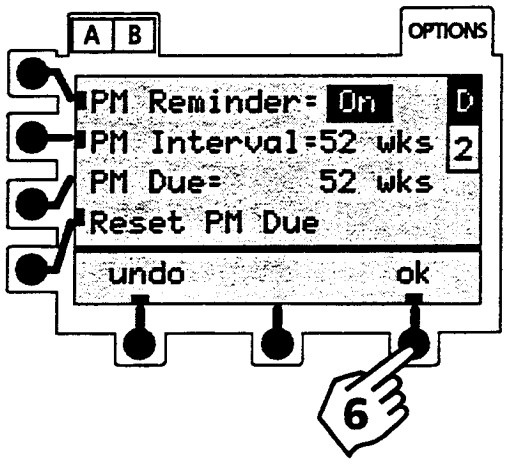
NOTE: Pressing the Reset PM Due soft key resets the PM Due to the displayed PM Interval.

6. Press **ok** to accept the change and return to the beginning of the D2 page.









6.4.3 Viewing Alarm or Error History (Event Log)

1. From the D2 page, press the **History** key. The History Log will keep all major changes (1000) to the pump in memory. Entry 01 will be the most recent and entry 1000(+) will be the oldest.

   For mode/state changes the first line will say Misc. Inst. (Miscellaneous Instruction). Alarms and errors may be channel specific or instrument related, this will also appear on the first line.

   The second line will give you the month, day, year, hour and minute the entry/event took place.

   The third line will show the event/entry that occured. Memory can be cleared in the History Log by disconnecting AC and battery power. Then press ON/OFF switch for 5 seconds. Reconnect AC and battery power. Memory should clear (no more events) and a refresh cycle on the battery begin.

NOTE: Memory will also clear when new main software is installed in the pump.

See list of entries below and examples of displays to the right.

Alarms:
ALL

Errors:
ALL

User Initiated Events:

Alarm Cleared	Panel Unlocked
Channel Off	Silence On
Channel On	Latch Open
Configuration Complete	AC Connected
Diagnostics Complete	AC Disconnected
Panel Locked	

Data Entry Events:

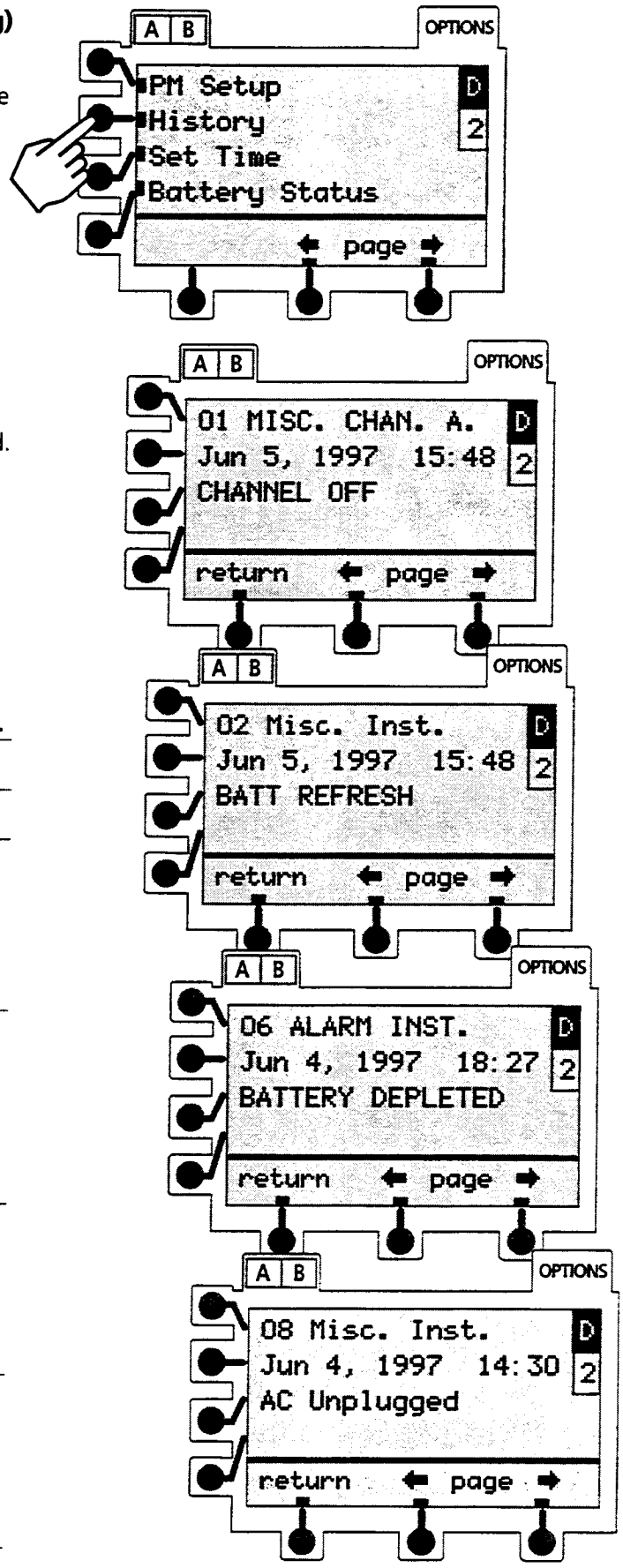
Dose (Rate) Calc VTBI Set to xxxx.x ml	Dose (Rate) Calc Set to OFF
Load(Dose) VTBI Set to xxxx.x ml	Primary VTBI Set to xxxx.x ml
Primary VTBI Set to Off	Secondary VTBI Set to xxx.x ml
Vi Cleared	Dose Rate Set to xxxxx uuu
Drug Amount Set to xxxxx uuu	Diluent Volume Set to xxxx ml
Patient Weight Set to xxxxx uuu	Patient Height (DRC) Set to xxx uuu
Set Time	Dose Rate Drug Name

Infusion State Change Events:

Dose (Rate) Running at xxx.x ml/hr	(Multi)Dose Started at xxx.x ml/hr
In KVO at xx.x ml/hr	Loading(Dose) Running at xxx.x ml/hr
Multi-Dose Complete	On Hold, VI = xxxx.x ml
Primary Runningat xxx.x ml/hr	Secondary Running at xxx.x ml/hr
(Multi)Step Started at xxx.x ml/hr	Timer Started, VI = xxxx.x ml
Timer Stopped, VI = xxxx.x ml	

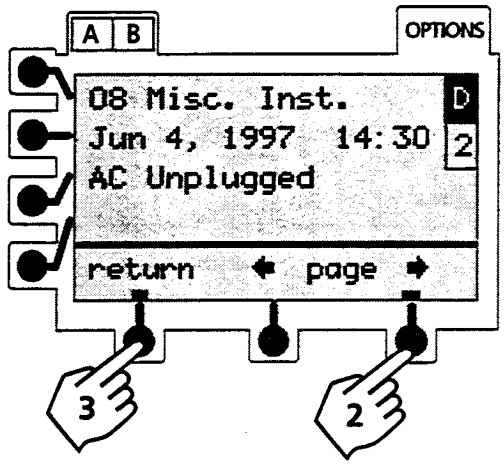
Notifications:

Battery refresh	Battery Low (ALERT)
Computer Released	Memory Erased
Pressure Restart	Preventive Maintenance Reminder
Resistance Restart	Resistance Alert
Self-Check required	Software Shutdown
Upstream Occlusion restart	VI = xxxx.x ml *(logged every hour while infusing)*



2. Pressing the **page** soft key enables you to scroll forwards and backwards to the next event screen. (Events are listed on a last in, first out basis.)
3. Press **return** soft key to return to the D2 page.

NOTE: If AC and battery power are disconnected from the instrument, event history may be lost.



6.4.4 Setting Time (and Date)

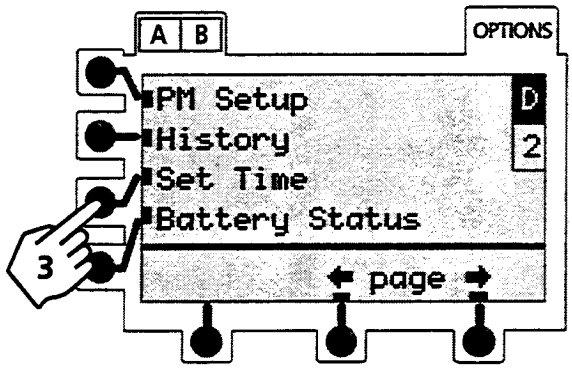
1. On the D2 page, press the **Set Time** soft key.
2. Press **Month** soft key to hightlight. Press Month soft key as needed to get desired month.
3. Press **Date** soft key to hightlight. Enter date on keypad and press enter.
4. Press **Year** soft key to highlight. Enter year on keypad and press enter.
5. Press **Time** soft key to highlight hours (military time, 24 hours) on keypad and press enter. If hours is correct and you only want to change minutes, press Time soft key again to hightlight minutes.

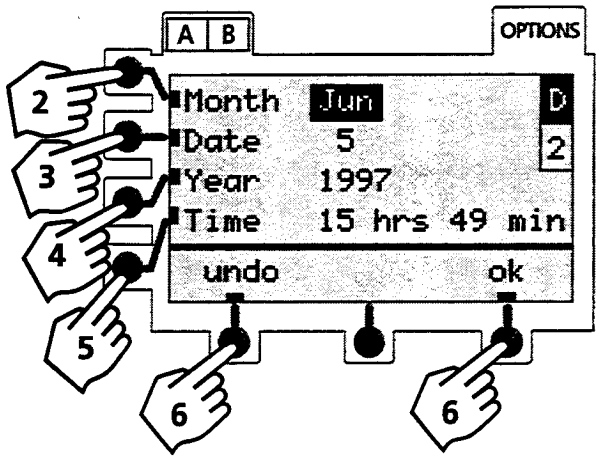
NOTE: The year setting is four digits and will accept year entries of 2000 and beyond.The default date and time is Jan 1 1970 00:00.

NOTE: The software clock may lose up to 3 minutes per month. Reset the time as part of Preventive Maintenance or more often as desired.

NOTE: When the clock is reset for current time/date the previous logs will not be adjusted retroactively (i.e. they will remain the same.)

NOTE: The clock will not automatically adjust for time changes such as daylight savings.





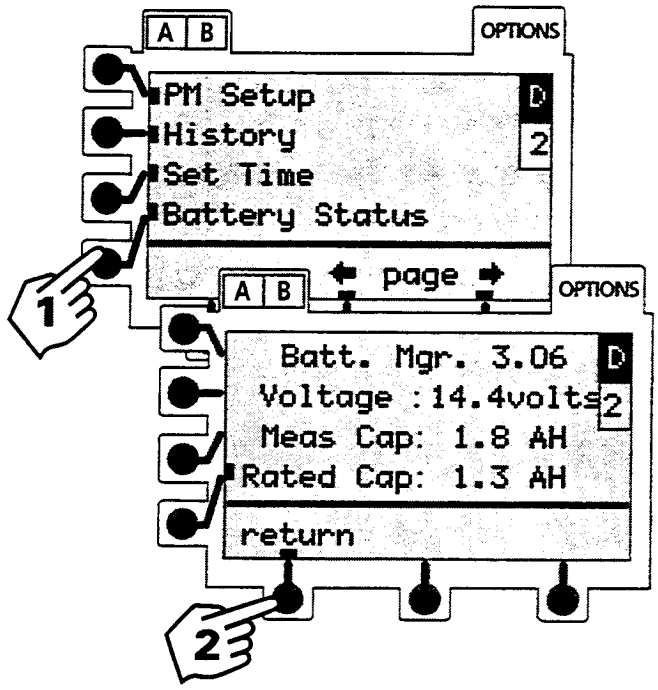
6. Press **ok** to accept the change and return to the beginning of the D2 page. Press the **Undo** softkey to reinstate time/date.

6.4.5 Viewing Battery Status

1. On the D2 page, press the **Battery Status** soft key. Voltage may range from 10V to 18V. Ampere-hours may range from 0.0 to 3.0.

NOTE: Voltage will flash when updated by software.

2. Press the **return** soft key to return to the D2 page.

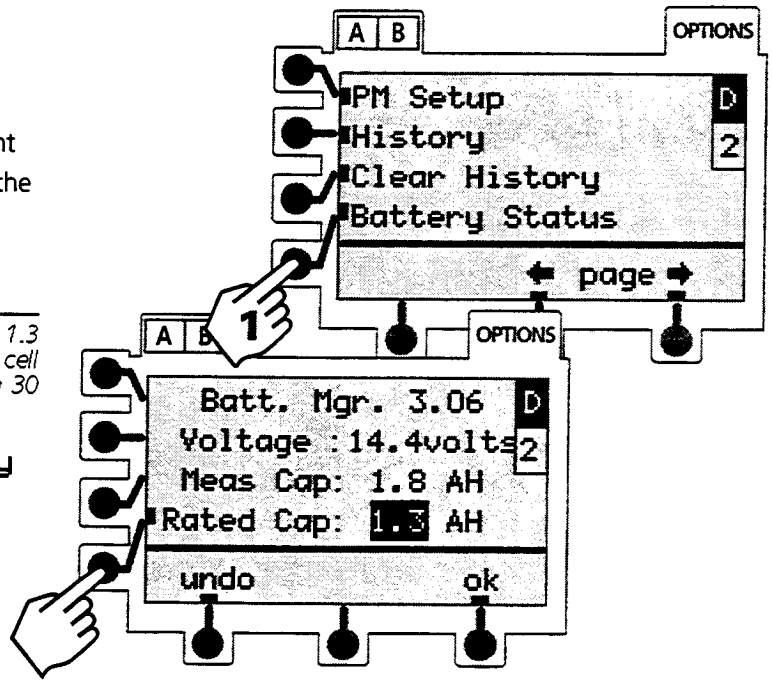


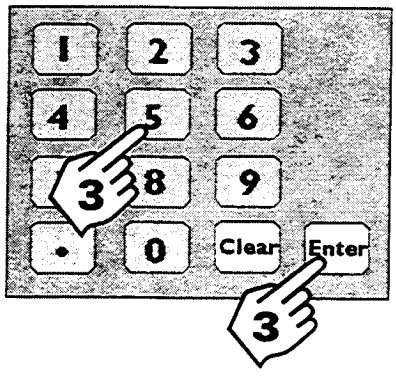
6.4.6 Changing Rated Capacity of Battery

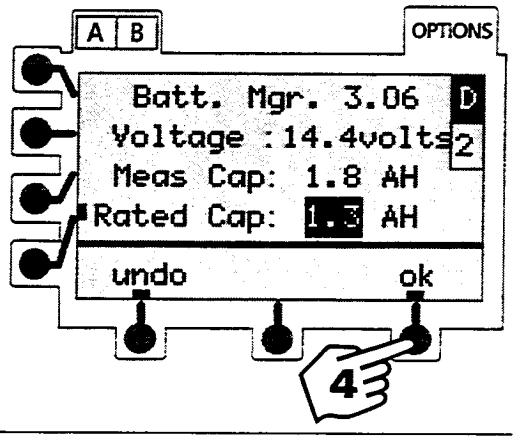
This step is only required if a different type or different capacity battery is later approved for use. As long as the battery is NiCad and rated at 1.3 Ah, no action is required.

NOTE: Battery is rated at 1.8 Ah under ideal conditions. 1.3 Ah will be entered here to help compensate for uneven cell capacity and ensure getting a "low battery alarm" with 30 minutes or more use on battery.

1. On the D2 page, press and release the **Battery Status** soft key.
2. Press and release the **Rated Capacity** soft key to highlight.
3. Use the numeric key pad to enter the rated capacity of the new battery. Press ENTER.
4. Press **ok** to accept the change and return to the beginning of the D2 page.

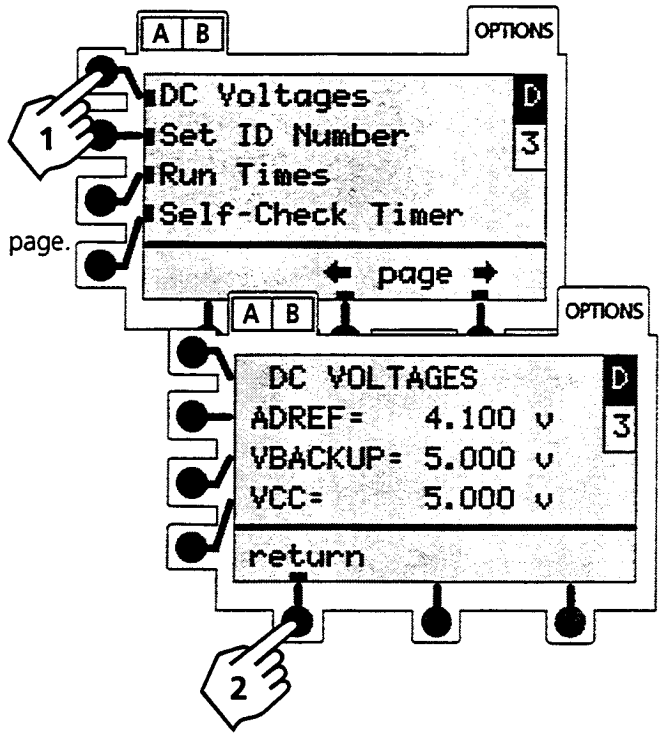






6.4.7 Viewing DC Voltages

1. Advance to the D3 page.
2. Press the **DC Voltages** soft key.
3. Press the **return** soft key to return to the D2 page.



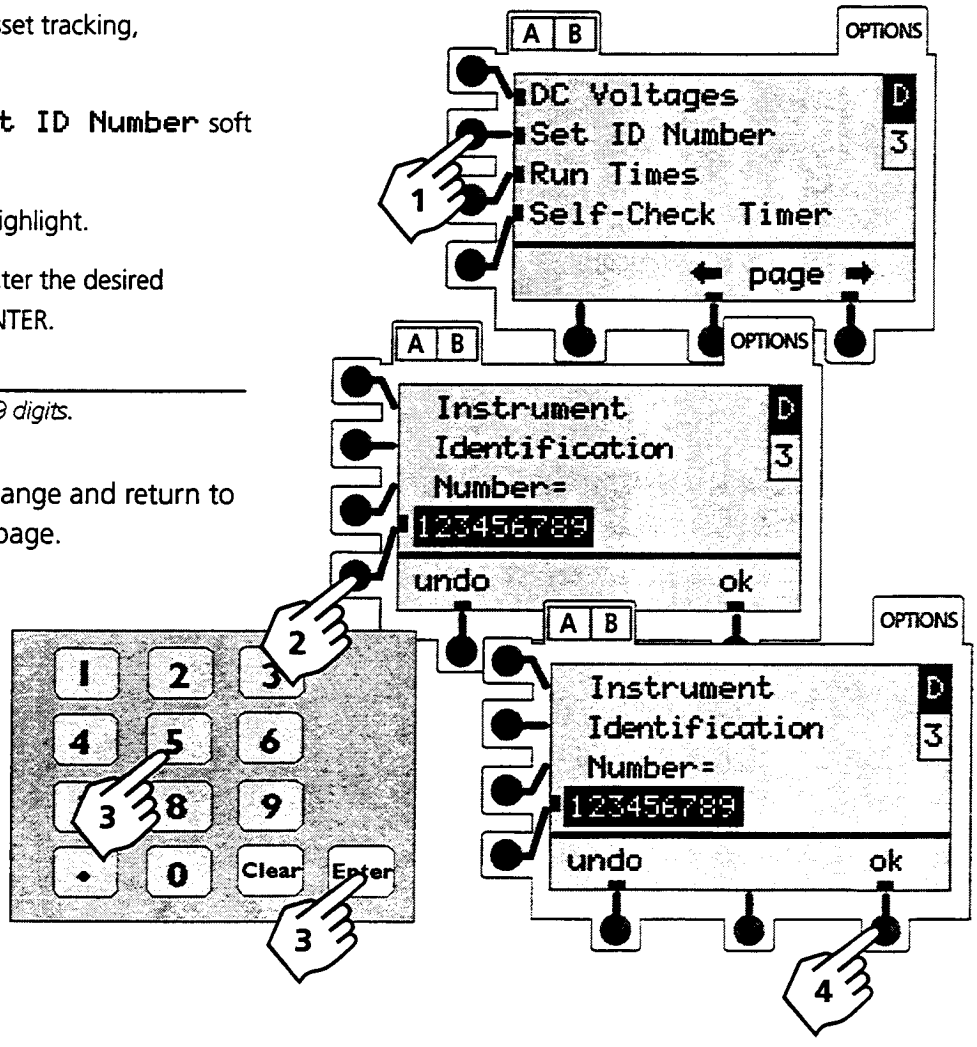
6.4.8 Setting ID Number

An ID number may be useful for asset tracking, maintenance records, etc.

1. On the D3 page, press the **Set ID Number** soft key.
2. Press bottom-left soft key to highlight.
3. Use the numeric key pad to enter the desired identification number. Press ENTER.

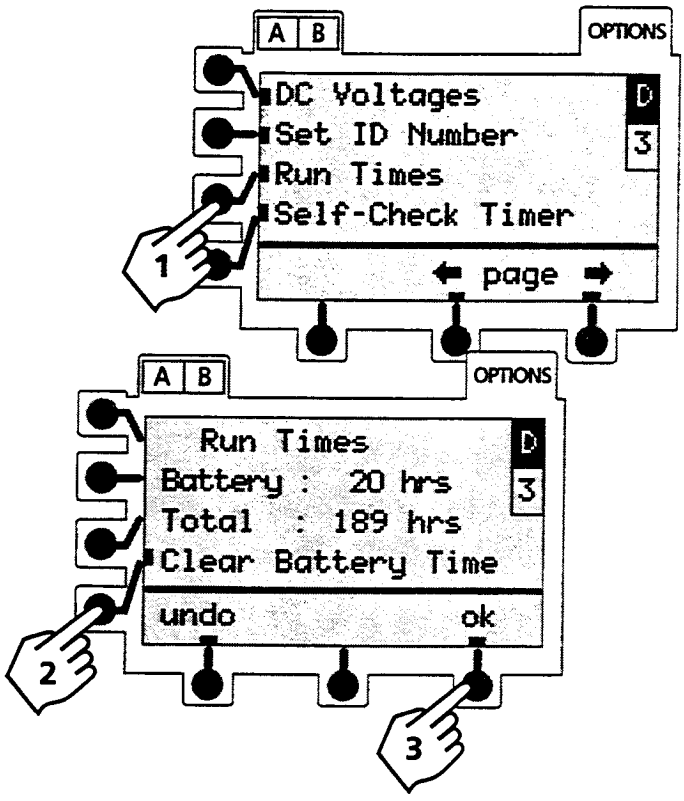
NOTE: The ID Number can be up to 9 digits.

4. Press **ok** to accept the change and return to the beginning of the D3 page.



6.4.9 Viewing Battery and Total Run Times

1. On the D3 page, press the **Run Times** soft key.
2. Press the **Clear Battery Time** soft key to clear battery run time. (Total run time will not clear.)
3. Press **ok** to accept the change and return to the beginning of the D3 page.



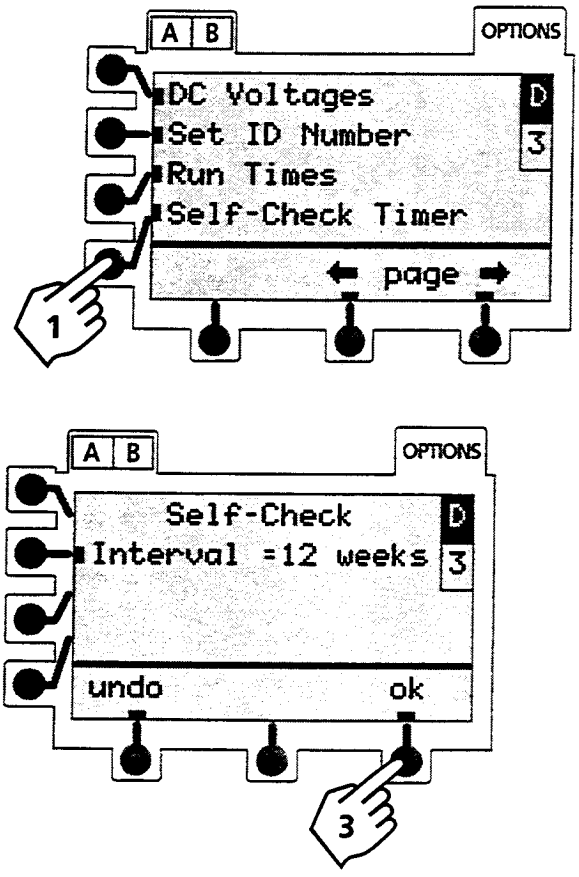
6.4.10 Viewing Self-Check Timer

The self-check timer is an interval at which the software checks the pressure sensor offset drift when it can be determined a set is not loaded and no other external forces are being applied to the pressure sensor. This periodic check ensures the set can be sensed as it is installed and removed. The instrument will ask the operator to remove the set before powering down.

1. On the D3 page, press the **Self-Check Timer** soft key.
2. Verify interval is set to 4 weeks.
3. Press **ok** to accept the change and return to the beginning of the D3 page.

NOTE: This setting is factory set (4 or 12 weeks) and should not be changed. This feature can be enabled/disabled via Diagnostics Mode on Page D7.

The self-check timer is set to four weeks. This is a rolling four week interval. To establish a new four week period, remove the set with the instrument power on and wait one to two seconds before turning the power off. (See the D6 page in section 6.4.17 for information on when the self-check was last completed.)



If a self-check due message appears, press continue to keep the instrument running. Ensure the instrument is on when the set is removed, wait one to two seconds, and then power off. If the instrument is powered off without following this sequence of steps, it will not run on the next power up. If the pump displays, "**Self Check is Due. Please Eject the Set**," this four week interval has elapsed. If that occurs:

1. Turn the instrument on and install the set.
2. Wait one minute.
3. Remove the set and watch the screen for a message that the self-check is in progress.
4. When the test is done, the screen will go back to the parameter page, and instrument operation can continue as desired.

6.4.11 Testing Channel Sensors

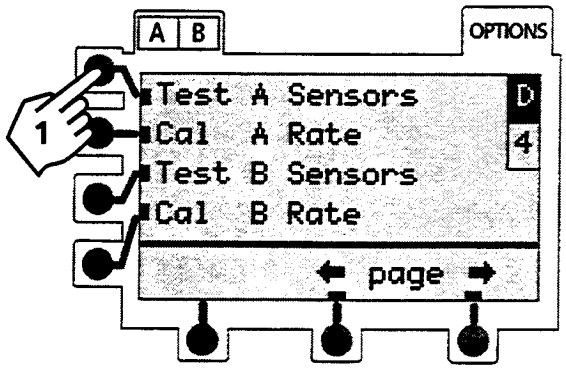
Advance to the D4 page.

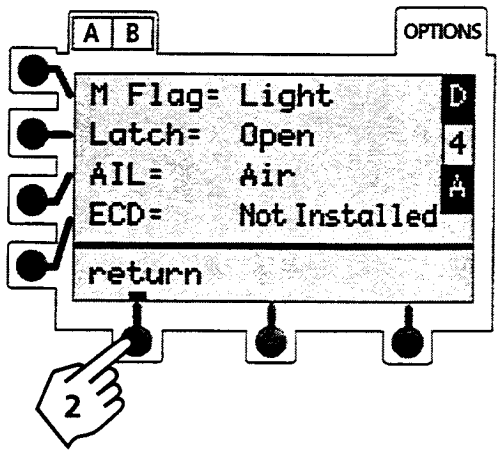
1. Press **Test A Sensors** or **Test B Sensors** soft key (dual channel instrument). The display will show "D4A" or "D4B" depending on which channel was selected.

   M Flag reads Light or Dark (Dark with 5th cam in).
   Latch reads Open or Closed.
   AIL reads Air or Fluid.
   ECD reads Air, Fluid, Unplugged, or Not Installed.

Displayed:	*Means:*
Not Installed	*ECD board assembly not installed.*
Unplugged	*ECD board assembly installed. Flow sensor not connected*
Air	*ECD board assembly installed. Flow sensor detects air.*
Fluid	*ECD board assembly installed. Flow sensor detects fluid.*

2. Press the **return** soft key to return to the D4 page.





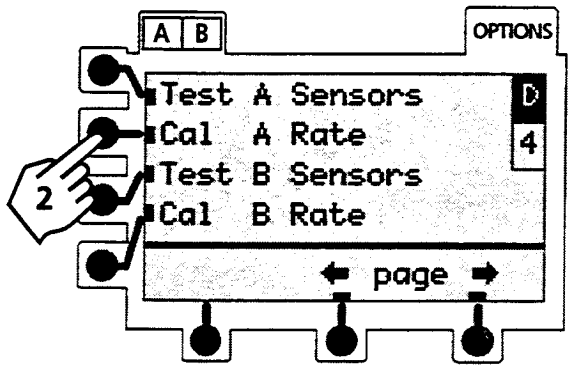
6.4.12 Viewing Rate Calibration Information

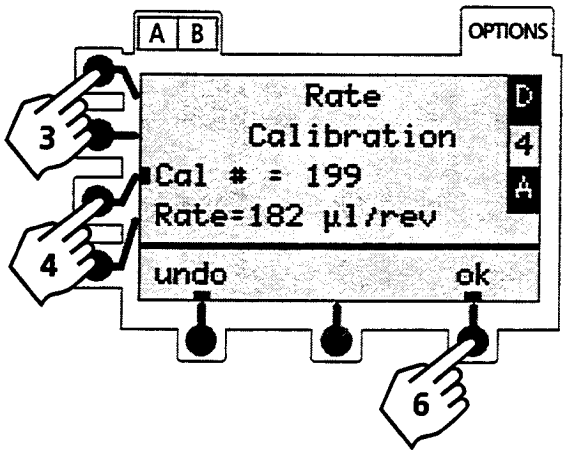
This page is for viewing only. Use the following procedure to verify the Cal # setting.

1. Advance to the D4 page.
2. Press **Cal A Rate** or **Cal B Rate** soft key depending on which channel is to be viewed.
3. Press Rate soft key two times. The pump will beep, but the display will not change.
4. Press Cal # soft key to highlight and select for editing.

NOTES: See Chapter 3 for specific rate accuracy verification testing. If the rate verification fails, see Chapter 5 for rate calibration procedure with software 2.02 and higher.

5. Use the numeric keypad to enter desired rate cal number. Press ENTER.
6. Press ok to accept the change and return to the beginning of the D4 page.



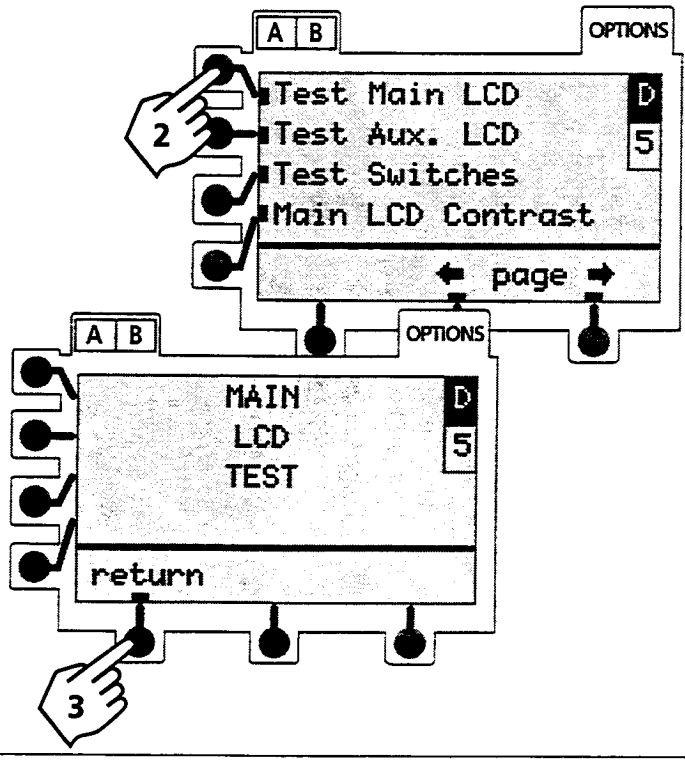


6.4.13 Testing Main LCD

1. Advance to the D5 page.
2. Press the **Test Main LCD** soft key.

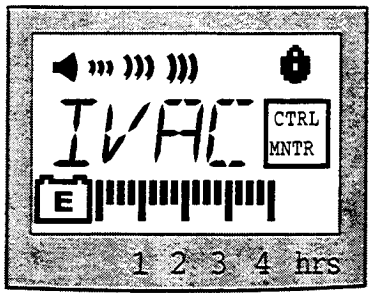
- The test consists of the Main LCD alternating between normal and reverse video every 2 seconds.
- All LEDs also flash on and off at a 2 second rate (with 2.02 software and higher).

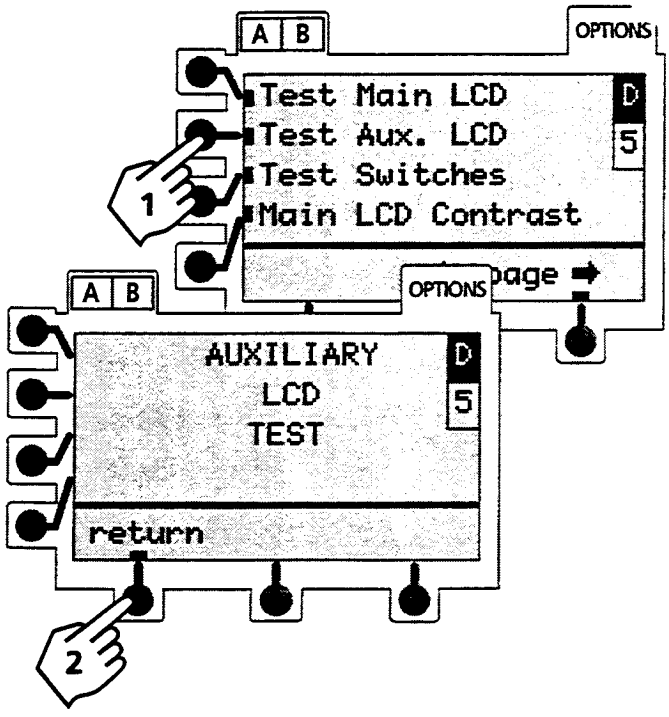
3. Press the **return** soft key to return to the D5 page.



6.4.14 Testing Aux (Lower) LCD

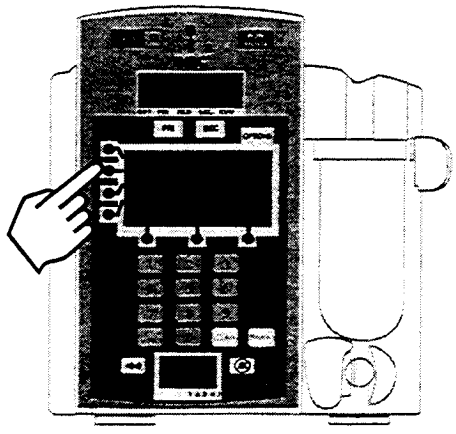
1. On the D5 page, press the **Test Aux. LCD** soft key.
   - This tests the Lower LCD Display, lighting all segments of the display.
2. Press the **return** soft key to return to the D5 page.

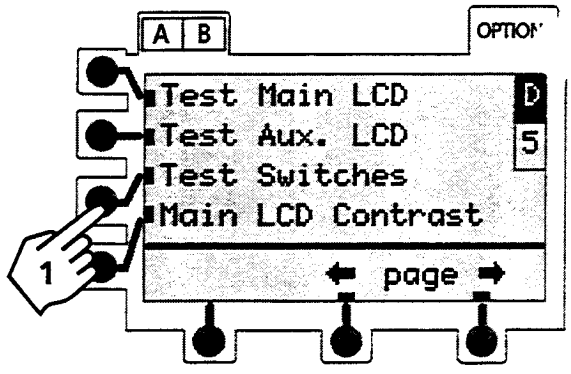


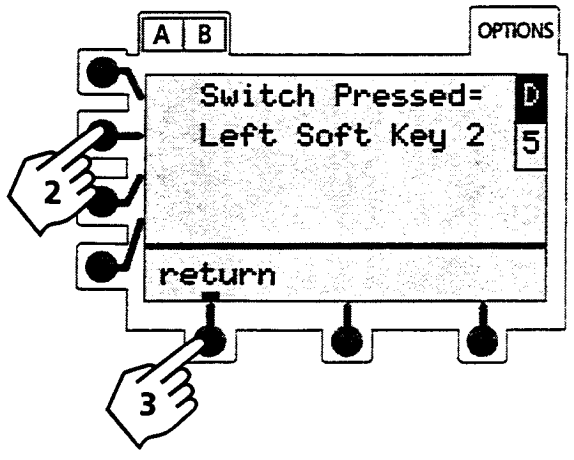


6.4.15 Testing Switches

1. On the D5 page, press the **Test Switches** soft key.
2. Proceed to press all keys on the instrument. As you press a key, the key's name will appear. Proper functionality of the **return** soft key is tested only by the key performing its function; i.e., returning the LCD to the D5 page.







NOTE: When the POWER key is pressed, it will display "Press and hold key to turn off".

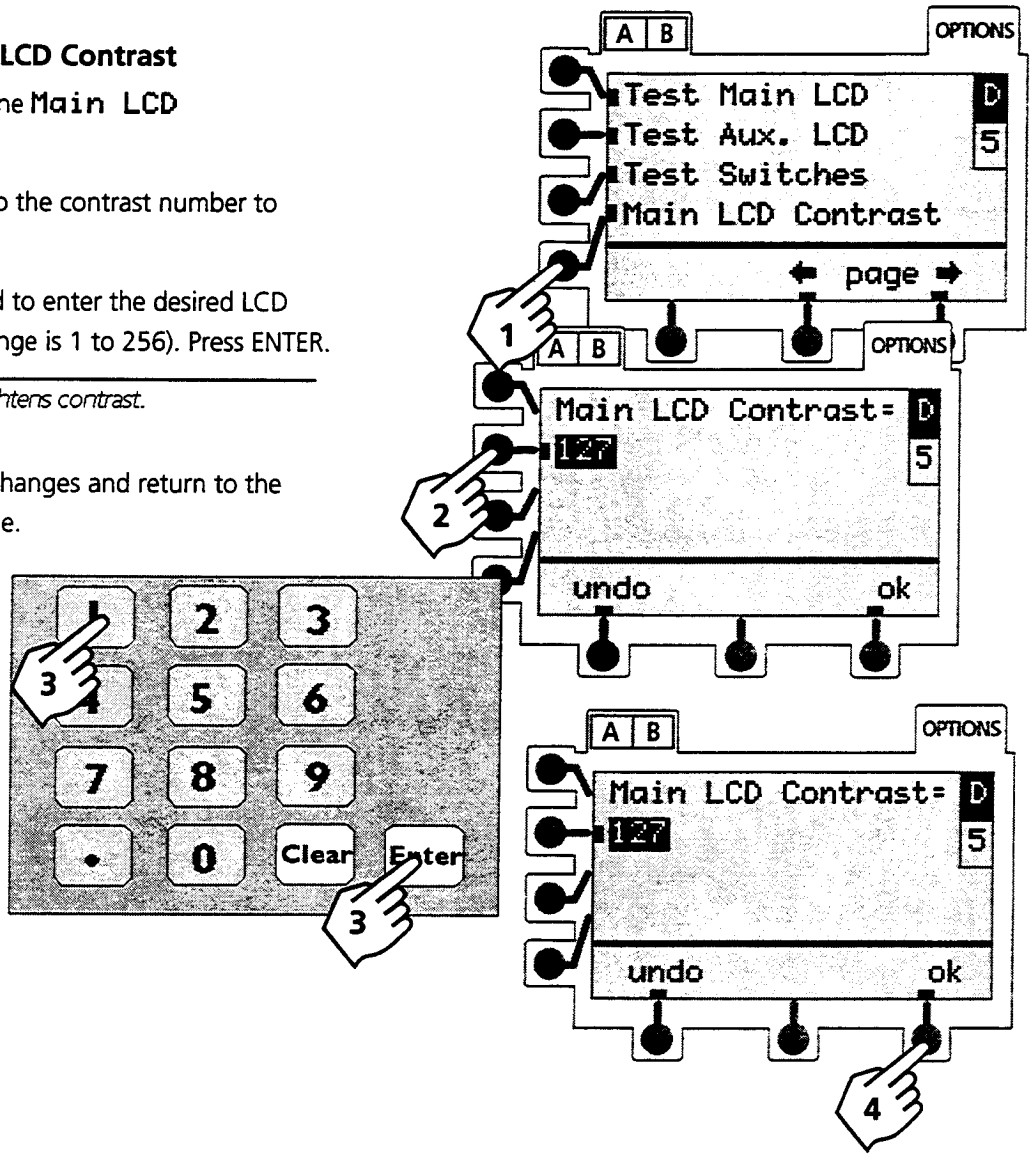
3. Press the **return** soft key to return to the D5 page.

6.4.16 Changing Main LCD Contrast

1. On the D5 page, press the **Main LCD Contrast** soft key.
2. Press the soft key next to the contrast number to highlight.
3. Use the numeric key pad to enter the desired LCD contrast (the contrast range is 1 to 256). Press ENTER.

NOTE: Decreasing number lightens contrast.

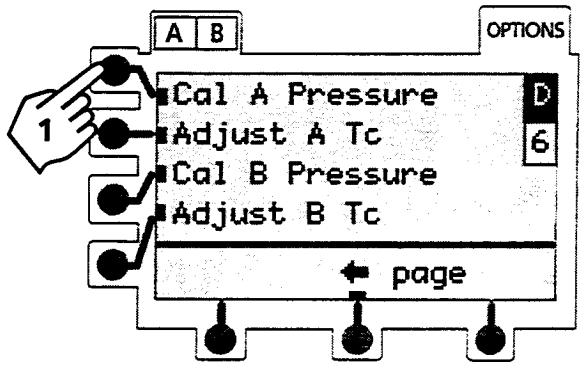
4. Press **ok** to accept the changes and return to the beginning of the D5 page.



6.4.17 Calibrating Channel Pressure

You will need to install a Pressure Cal Set (P/N 701SS) to apply pressure to each channel. Allow the instrument to warm up for a minimum of 1 hour while in the Diagnostics Mode.

1. On the D6 page, press **Cal A Pressure** or **Cal B Pressure** (dual channel). The display will show "**D6A**" or **D6B**" depending on which channel was selected.
2. Both "0" and "500" should display a number and say "**Pass.**" "Sensor=" should have a value between -30 and +80 (mmHgS). If **X**'s appear or the sensor reading is out of range, the instrument will require soft pressure calibration (see Chapter 3 for setup):

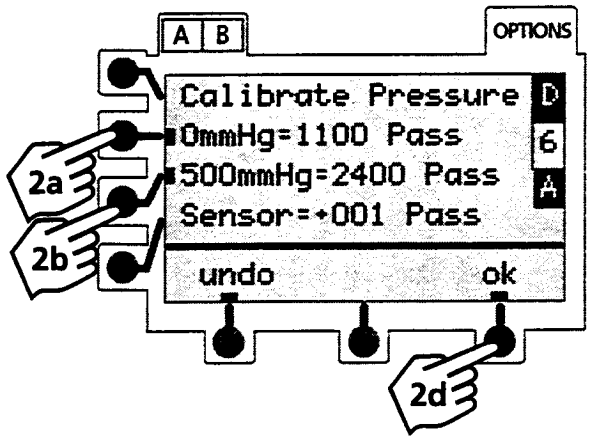


a. Adjust pressure to 0 mmHg from the test fixture. Press and release the 0 mmHg soft key. If readings are in a valid range, it will display Pass.

b. Apply 500 mmHg (±2 mmHg) from the test fixture. Press and release the 500 mmHg soft key. If readings are in a valid range, it will display Pass.

c. Remove 500 mmHg pressure applied to instrument, then remove set.

d. Press the **ok** soft key to accept the calibration and return to the D6 page.



3. Additional messages for pressure calibration include:

- **COMPLETE PRESS CAL** — need to do both "0" and "500" pressure cal points.
- **FAIL 500 LOW/HIGH LIMIT** — Pressure reading seen by ADC out of range. Retry soft pressure cal, perform hard cal, or return to ALARIS Medical Systems for repair, or replace mechanism.
- **FAIL ZERO LOW/HIGH LIMIT** — Pressure reading seen by ADC out of range. Retry soft pressure cal, perform hard cal, or return to ALARIS Medical Systems for repair or replace mechanism.
- **FAIL ZERO LOW/HIGH RANGE** — Pressure reading outside relative limits. Retry soft pressure cal, perform hard cal, or return to ALARIS Medical Systems for repair, or replace mechanism.
- **SENSOR TOO NOISY** — Electrical interference detected in pressure signal. Retry soft pressure cal, perform hard cal, or return to ALARIS Medical Systems for repair or replace mechanism.

NOTE: The hard cal procedure is in Chapter 5.

4. Messages that require instrumentsto be returned to ALARIS Medical Systems for repair or mechanism replacement are:

- **FAIL SENSOR GAIN LOW/HIGH**
- **FAIL VBRIDGE LOW/HIGH**
- **XDCR TEST FAIL LOW/HIGH**
- **ZERO RANGE TOO SMALL**

NOTE: Perform TEMP CAL message means TC ≠ 0.0 in Adjust Tc Section. This may occur when main board is replaced.

5. Additional self-check information may also be viewed.

a. Press the sensor reading soft key.

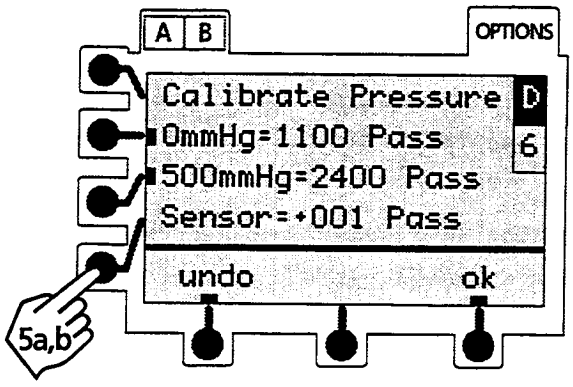
b. **Pass** will be displayed. Press the soft key again.

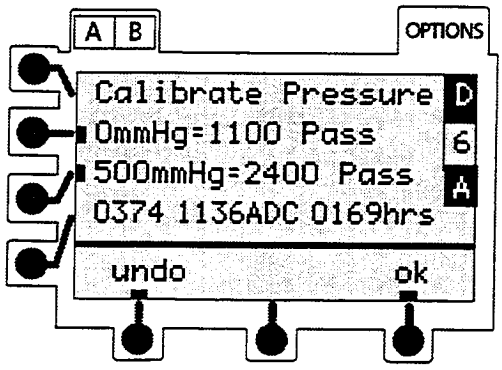
- Three numbers will appear in the lower portion of the display.
- The number on the left represents the number of times the self-check has been performed since the last soft pressure calibration.
- The center number represents the zero pressure reading at the time of the last self check.
- The number on the right represents the number of hours since the last self-check was performed. This should not exceed 672 hours, or else the instrument will display the message, "**Self Check is Due, Please Eject the Set.**"

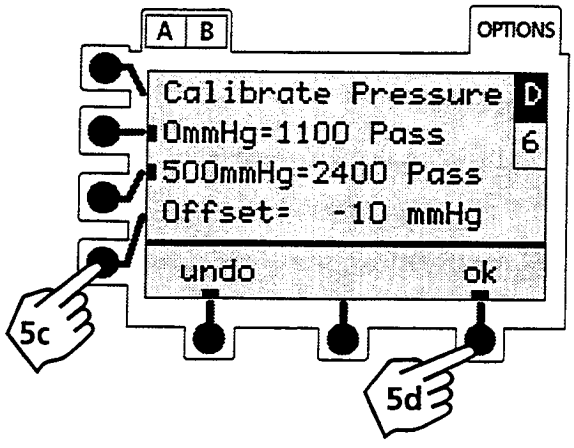
c. Press lower left soft key again. The OFFSET will be displayed. This value is used to help determine when the unit will go into a "SET OUT" alarm. When the AUTO-ZERO feature is on/enabled, the level must be less than 55 mmHg. Adding the OFFSET level to the SENSOR = reading (looked at in step 2) which should be less than 55 mmHg to prevent a "SET OUT" alarm. If AUTO-ZERO is off/disabled then the OFFSET level is not used and the SENSOR = reading must be less than 90 mmHg to prevent a "SET OUT" alarm.

The OFFSET level is updated when the pump does the SELF CHECK on sete eject. This level will be set to zero when soft pressure calibration is done.

d. Press the OK soft key again to return to Main D6 page.





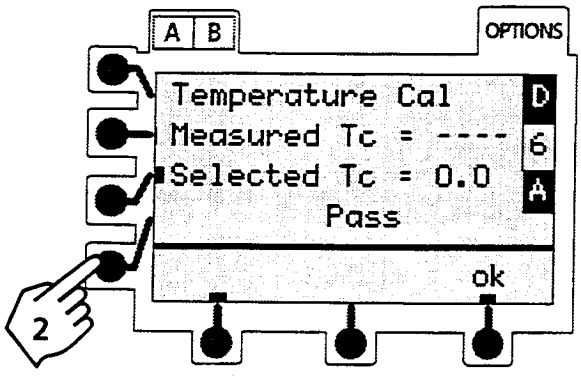


6.4.18 Viewing Temperature Calibration Information

This page is for viewing only. Temperature Calibration (Tc) is factory set only for temperature compensation of transducer, if needed.

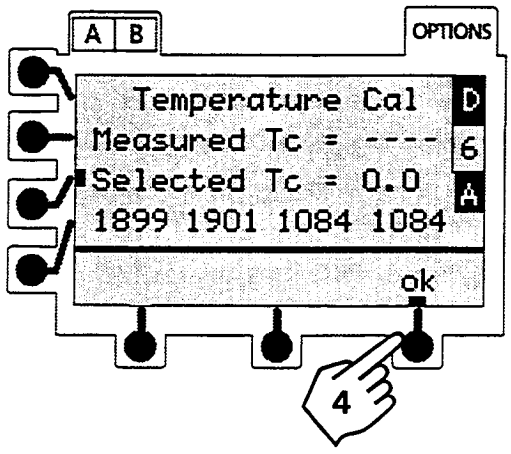
1. On the D6 page, the display will show the measured and selected Tc, and say "**Pass**".

2. Press the **Pass** soft key to see the values for the hard pressure calibration.



NOTE: Measured Tc may be all dashes or show a number. Selected Tc must be 0.0 if software is 2.02 and higher.

3. Four numbers will appear in the lower portion of the display.



   - The number on the left represents the Vbridge value in ADC counts at the last soft pressure cal.
   - The second number represents the current Vbridge value in ADC counts.
   - The third number is the uncompensated sensor value in ADC counts. This is the number that will be used to perform hard pressure calibration. This number should be between 1000 and 1300. If not in this range, a hard pressure calibration should be performed. Refer to Chapter 5 for the hard pressure cal procedure.
   - The fourth number is the compensated sensor value in ADC counts.

The difference between the left two numbers shows the change in the transducer over time.

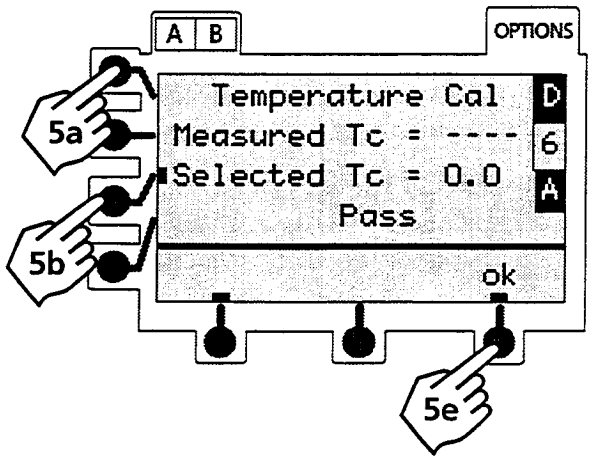
The difference between the two right numbers shows the change in the transducer due to temperature.

1 ADC count = 0.37 mmHgs

1.5 mmHgS = 1 mmHg

4. Press the **ok** soft key to return to the main D6 page.

5. To change a Selected TC, perform the following:



   a. Press the upper left soft key twice. The only response will be two beeps.

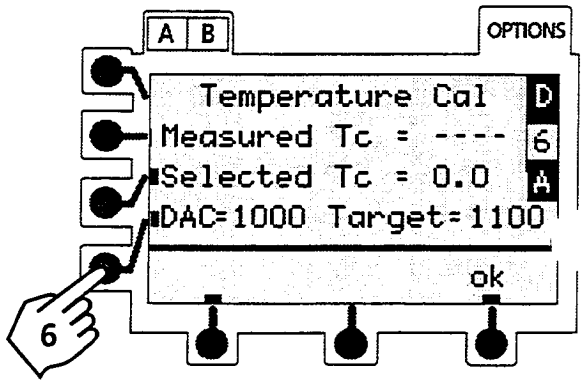
   b. Press the **Selected Tc** soft key.

   c. Use the numeric keypad to enter 0.0.

   d. Press ENTER.

   e. Press ok.

NOTE: Selected Tc=0.0 with software is 2.02 or higher. If not, will get Perform Temp Cal message when in pressure calibration (soft).



6. Pressing lower left soft key from the Step 3 will show DAC information. It is for future use and not to be used at this time.

6.4.19 Configuring Pressure System Auto Zero

1. Press upper left soft key to access Auto Zero option.
2. Press bottom center soft key to access other screens in Diagnostics Mode.
3. Press Auto Zero soft key to highlight settings. Press Auto Zero soft key again to change between "On" and "Off".
4. Press "ok" to accept change and return to main D7 page. Press "undo" to return to previous setting.